Journal and Proceedings

OF

The Royal Society of Western Australia.

PATRON: HIS MAJESTY THE KING.

Volume VI.

PART II.

1919 - 1920.

The Authors of Papers are alone responsible for the statements made and the opinions expressed therein.

PRICE: Two Shillings and Sixpence.

Perth:
BY AUTHORITY: FRED. WM. SIMPSON, GOVERNMENT PRINTER.
1921.

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CONTENTS OF PARTS I. AND II.

LIST OF OFFICERS, 1919–1920.

PATRON:
His Majesty the King.

VICE-PATRON:
His Excellency Sir Francis Alexander Newdegate.

PRESIDENT:
G. L. Sutton.

VICE-PRESIDENTS:
Edward S. Simpson, D.Sc., B.E., F.C.S.
C. E. Lane-Poole.

PAST PRESIDENTS:
1914–15—Professor W. J. Dakin, D.Sc., F.L.S., F.Z.S.
1915–16—A. Gibb Maitland, F.G.S.
1916–17—Professor A. D. Ross, M.A., D.Sc., F.R.S.E., F.R.A.S.
1917–18—A. Montgomery, M.A., F.G.S.
1918–19—William J. Hancock, M.Inst. C.E., M.I.E.E.

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D. A. Herbert, M.Sc.
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W. A. Saw.

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ACTING HONORARY SECRETARY:
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S. K. Montgomery, B.A., B.Sc.

POSTAL ADDRESS AND PLACE OF MEETING:
The Museum,
Beaufort Street,
Perth,
Western Australia.

LIST OF MEMBERS.

ON 30TH JUNE, 1920.

Honorary Members.

Bird, Mrs. A. M., The Old Farm, Albany.
Cooke, Prof. W. E., M.A., F.R.A.S., The Observatory, Sydney, New South Wales.
Diels, Dr. Ludwig, University of Marburg, Germany.
French, Charles, F.L.S., F.R.H.S., Melbourne.
Maiden, J. H., F.R.S., F.L.S., Government Botanist, Sydney.
Milligan, A. W., c/o. Royal Australasian Ornithologists' Union, Melbourne.
Pritzel, Dr. E., University of Marburg, Germany.

Corresponding Members.

Cheel, Edwin, Botanic Gardens, Sydney.
Hedley, C., F.L.S., Australian Museum, Sydney.

Ordinary Members.

Alder, Miss, 237 Beaufort Street, Perth.
Aldrich, F., Fisheries Department, Perth.
Alexander, W. B., M.A., Museum, Perth.
Allum, F. E., Royal Mint, Perth.
Allum, Miss Enid, Royal Mint, Perth.
Andrews, Cecil, M.A., View Street, Cottesloe.
Aurousseau, M., Mc., B.Sc., University, Perth.
Blackall, W. E., M.D., F.R.C.S., L.R.C.P., Leake Street, Cottesloe.
Blatchford, T., B.A., Mines Department, Perth.
Boas, I. H., B.Sc., Technical School, Perth.
Boultbee, G. F., Commercial Union Chambers, Perth.
Bowley, H., Geological Survey Department, Perth.
Clarke, E. de C., M.A., Geological Survey Department, Perth
Creeth, F. B., 39 Broome Street, Cottesloe.
Creeth, Miss M. E., 38 Wilson Street, Perth.
Curlewis, H. B., B.A., F.R.A.S., Observatory, Perth.
Dakin. Prof. W. J., D.Sc., F.L.S., F.Z.S., University, Perth.
Dakin, Mrs. W. J., B.Sc., Charles Street, South Perth.
Farquharson, R. A., M.A., M.Sc., F.G.S., Geological Survey Office, Perth.
Feldtmann, F. R., Geological Survey Department, Perth.
Galbraith. A. R., M.I.C.E., City Engineer, Town Hall, Perth.
Grasby, W. Catton, F.L.S., West Australian Chambers, Perth.
Gray, H. J., M.B., B.S., 25 Richardson Street, Perth.
Hall, A. J., 7 Ruby Street, North Perth.
Hancock, W. J., M.I.C.E., M.I.E.E., Public Works Department, Perth
Hancock, Mrs. W. J., 47 Forrest Avenue, Perth.
Herbert, D. A., M.Sc., Government Analyst's Department, Perth.
Holmes, H. D., W.A. Bank, Perth.
Honman, C. S., B.M.E., c/o. Macartney & Honman, Kalgoorlie.
Johnson, Miss E., "Glen Lyn," Shenton Road, Claremont.
Kingsmill, Hon. W., B.A., M.L.C., Parliament House, Perth.

LIST OF MEMBERS—*continued.*

Knapp, A,. B.O.A., Altona Street, Perth.
Lane-Poole, C. E., Forestry Department, Perth.
Lefroy, H. Maxwell, Ventnor Avenue, Perth.
LeSouef, E. A., B.V.Sc., Zoological Gardens, Perth.
Lipfert, O. H., The Museum, Perth.
Lotz, H. J., F.R.C.S., D.P.H., M.R.C.S., L.R.C.P., Palace Court, Perth
Lovegrove, F., M.B., Tambellup.
Lowe, Miss, Government Girls' School, James Street, Perth.
Lukin, Mrs., Roberts Road, Subiaco
Maitland A. Gibb, F.G.S., Geological Survey Department, Perth.
Maitland, Mrs. Gibb, Ventnor Avenue, Perth.
Male, A.. M.L.A., King's Park Road, Perth.
McGhie, L., Department of Agriculture, Perth.
McMillan, Hon. Sir Robert, Chief Justice, View Street, Cottesloe.
Montgomery, A., M.A., F.G.S., Mines Department, Perth.
Montgomery, Mrs. A., 30 Richardson Street, Perth.
Montgomery, S. K., B.A., B.Sc., University, Perth.
Nisbet, Miss J. A., Education Department, Perth.
O'Connor, Dr. M., Weld Club, Perth.
Oldham, Hugh, Public Works Department, Perth.
Parkinson, W. C., Carnegie Institution Magnetic Observatory, Watheroo.
Paton, D. D., M.A., M.B., Ch.B., D.O., 68 St. George's Terrace, Perth.
Perry, B., Kenny Street, West Guildford.
Riley, Right Rev. C.O.L., D.D., Archbishop of Perth, 223 St. George's Terrace. Perth.
Rolland, R. A., 29 Walker Avenue, Perth.
Ross, Prof. A. D., M.A., D.Sc., F.R.S.E., F.R.A.S., University, Perth.
Ross, Mrs. A. D., B.Sc., Ventnor Avenue, Perth.
Saw, W. A., Land Titles Office, Perth.
Shelton, Mrs., 20 Kershaw Street, Subiaco.
Shelton, W. E., B.Sc., 116 Heytesbury Road, Subiaco.
Simpson, E. S., D.Sc., B.E., F.C.S., Geological Survey Department, Perth.
Sutherland, W. G., Fremantle Trading Co., Fremantle.
Sutton, G. L., Department of Agriculture, Perth.
Shields, W. H., B.Sc., 42 Swanbourne Terrace, Cottesloe Beach.
Talbot, H. W. B., Geological Survey Department, Perth.
Thompson, J., B.E., M.Inst.C.E., Esplanade, Cottesloe.
Tomlinson, A., M.Sc., University, Perth.
Trethowan, W., M.S., 267 St. George's Terrace, Perth.
Watkins. A. O., A.R.S.M., F.G.S., 67 Malcolm Street, Perth.
Whalley, Rev. D. T., Alberton, S.A.
Webster, Alfred, M.D., 229 St. George's Terrace, Perth.
Wood, J. A., Government School, Darkan.
Woolnough, Prof. W. G., D.Sc., University, Perth.
Zabel, Mrs. F., 621 Hay Street, Perth.

Associate Members.

Allen, F. B., M.A., B.Sc., F.L.S., Technical School, Perth.
Campbell, W. D., A.K.C., F.G.S., A.M.I.C.E., Lucknow, St., Willoughby, New South Wales.
Clark, J., 54 Jewell Street, Perth.
Cleland, J. Burton, M.D., Department of Public Health, Macquarrie Street, Sydney, New South Wales.
Creeth, Mrs. F. B., Broome Street, Cottesloe Beach.
Duffy, Mrs. Gavan, 11 Heytesbury Road, Subiaco.

LIST OF MEMBERS—*continued.*

Gribble, Rev. E. R., Forrest River Mission, Wyndham.
Hardy, G. H., Museum, Hobart, Tas.
de Later, M., Kelmscott.
Hussey, Miss Lesley, B.A., Girls' Grammar School, Perth.
Lapsley, R. G., Government Analyst's Department, Perth.
Le Mesurier, C. J. R., 39 St. George's Terrace, Perth.
Lodge, Mrs., 31 Congdon St., Osborne
Lovegrove, Mrs., Tambellup.
Norman, Mrs., Palace Court, Perth.
Paton, Mrs., 16 King's Park Road, Perth.
Pearson, H. E., B.A., B.Sc., Modern School, Perth.
Pelloe, Mrs. T., Adelaide House, Perth.
Shelton, Mrs. W. E., 116 Heytesbury Road, Subiaco.
Shelton, Miss K., 20 Kershaw Street, Sukiaco.
Shugg, H. G., School of Agriculture, Narrogin.
Simpson, Mrs. E. S., "Carlingford," Mill Point, South Perth.
Steedman, H., Suburban Road, Victoria Park, Perth.
Watson, Mrs. H., "Inchbrayock," South Perth.
Watson, Miss P., "Inchbrayock," South Perth.
Wright, A. R. L., L.R.I.B.A., Public Works Department, Perth.
Wood, W. E., Existing Lines Branch, Railway Department, Perth.

Total Membership.

Honorary Members	7
Corresponding Members	2
Ordinary Members	75
Associate Members	27
Student Members	...
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Royal Society of Western Australia.

ANNUAL REPORT FOR THE YEAR 1919–20.

Your Council begs to submit the annual report for the year ending 30th June, 1920.

During the year two new members, one corresponding member and three associate members were elected, one student member and one associate being elected as ordinary members.

His Excellency the Governor accepted the position of Vice-Patron of the Society.

A Field Naturalists' and Excursion Committee was elected and consisted of five members Miss Creeth, Messrs. Alexander, Clark, Hall, and Herbert. Excursions were held to Perry's Lime Kilns, Gingin, Lake Yangebup, Swanview, Greenmount, and Garden Island.

The rules were revised and the amended rules were printed in Volume V. of the Proceedings. Owing to the inclusion of Past Presidents as *ex-officio* members of the Council, there were three vacancies to be filled, and Dr. Lovegrove, Dr. Lotz and Mr. Herbert were elected.

A committee for the nomenclature of economic plants was appointed, and consisted of Messrs. Alexander, Lane-Poole, and Herbert. The list drawn up was printed in Part I. of Volume VI. of the Proceedings.

A committee consisting of Dr. Simpson, Professor Ross, and Professor Dakin was appointed to carry out tests on water divining. A preliminary report was submitted, and tests are still proceeding.

Mr. J. H. Maiden, F.R.S., an Honorary Member of the Society was chosen as respresentative of the Society at an Interstate Conference of Scientific Societies convened by the Royal Society of New South Wales.

Owing to the departure of Mr. Alexander for England on extended leave, Mr. D. A. Herbert was appointed Acting Honorary Secretary from December, 1919.

A letter was forwarded to the Minister for Lands protesting against the proposed lease of Barrow and Bernier Islands, but the Minister did not see his way clear to reserve the islands. A letter was forwarded to the lessee of the islands urging him to protect the peculiar native fauna.

The Annual Conversazione was held on May 29th at the University.

An address of welcome, in the form of a scroll mounted on banksia rollers was presented by the Society to the Prince of Wales on the occasion of his visit to the State.

The following papers were read before the Society during the year :—

Evidences of Uplift in the neighbourhood of Perth, J. L. Somerville.

Notes on Western Australian Lampreys, W. B. Alexander.

Notes on Climbing of Waterfall by Lampreys at Beedelup Brook, D. A. Herbert.

Notes on Occurrences of Boulders, possibly glaciated, near Leonora and Laverton, E. de. C Clarke.

Xanthorrhoœ reflexa, a new species of Blackboy, D. A. Herbert.

A new species of *Daviesia* from W.A., E. Cheel.

Aboriginal Names of Animals of the Lyons River District, W. B. Alexander.

Confusion between three Western Australian species of Acacia, D. A. Herbert.

Relation of Moisture Content of Wheat to Atmospheric Humidity, G. L. Sutton.

Recent Work on Australian Longitudes, H. B. Curlewis.

Some *Hymenosomidæ* from the Swan River, S. K. Montgomery.

Cobaltiferous Epsomite at Parkerville, E. S. Simpson.

Influence of External Attraction on the Prismatic Compass, M. Aurousseau.

Notes on Western Australian Ants-Nest Beetles, J. Clark.

Contributions to the Flora of W.A., No. I, D. A. Herbert.

Einstein's Theory of Relativity and New Ideas regarding Space and Time, Professor A. D. Ross.

The Occurrence of three species of Stenochiton in Western Australia, Edwin Ashby.

Presidential Address—Science and Agriculture—G. L. Sutton.

In addition to these a list of the vernacular names of economic plants was drawn up by Messrs. Alexander, Lane-Poole, and Herbert at the request of the Advisory Council of Science and Industry, and published in Part I. of Volume VI. of the proceedings.

(Signed) G. L. SUTTON,
President.

(Signed) D. A. HERBERT,
Honorary Secretary.

ROYAL SOCIETY OF WESTERN AUSTRALIA.

STATEMENT OF RECEIPTS AND EXPENDITURE FOR THE YEAR ENDED THE 30TH JUNE, 1920.

RECEIPTS.	£	s.	d.	EXPENDITURE.	£	s.	d.
Subscriptions	80	1	3	Printing Vol. V. of Journal ...	66	9	2
Interest on Banking Account ...	0	15	5	Binding Journals	1	15	0
Authors' Fees for Reprints of Papers in Journal	15	2	7	Postage and Petty Expenses...	17	7	11
Sale of Old Paper	1	5	0	Fees to Museum	12	0	0
				Printing Wrappers	2	14	0
Total Receipts during the Year	97	4	3	Total Payments during the Year	100	6	1
Balance in hand on the 1st July, 1919				Balance in hand on the 30th June, 1920—			
£ s. d.				£ s. d.			
At Bank ... 35 8 6				At Bank ... 31 19 2			
In Cash ... 0 16 10				In Cash ... 1 4 4			
	36	5	4		33	3	6
	£133	9	7		£133	9	7

F. E. ALLUM,
Hon. Treasurer.

Audited and found correct.
STEPHEN MONTGOMERY, B.A., B.Sc.
D. A. HERBERT,
} Auditors.

PROCEEDINGS OF THE ROYAL SOCIETY OF WESTERN AUSTRALIA.

12th August, 1919: The President, Mr. G. L. Sutton, in the Chair. A Field Naturalists' and Excursion Committee was elected, consisting of Miss Creeth and Messrs. Clark, Herbert, Hall, and Alexander. Mr. Alexander exhibited specimens of Fraser's Slow-worm (*Delma fraseri*), Gouldian Finch (*Poephila gouldiae*) with male plumage on the right half of the body and female on the left; a hybrid between the Longtailed finch (*Poephila acuticauda*) and the Banded Finch (*Schizoptera bichenovii*), interesting because the parents are placed in different genera; and the Crested Penguin (*Eudyptes chrysocome*) obtained at Albany, a rare straggler to the Australian coast from the Southern Ocean. After an introduction of the subject by Mr. W. C. Grasby, F.L.S., the Rev. W. Kennedy gave a demonstration of water divining, and submitted himself to tests drawn up by a committee consisting of Dr. Simpson and Professors Ross and Dakin. These preliminary tests indicated that it was worth while continuing the investigation and the committee was requested to proceed with further tests.

9th September, 1919: The President, Mr. G. L. Sutton, in the Chair. Mrs. Pilkington, Miss de Castilla, and Captain M. McVicker Smyth were elected as associates. Mr. Alexander gave a report on an excursion to Perry's Lime Kilns. Mr. J. M. Somerville, B.Sc., read a paper on "Evidences of Recent Uplift in the Neighbourhood of Perth," with details of numerous raised beaches on the banks of the lower Swan and Blackwood Rivers, pointing to the conclusion that a narrow strip of coast had undergone a recent uplift amounting in some localities to 20 feet.

14th October, 1919: The President, Mr. G. L. Sutton, in the Chair. Mrs. Pelloe was elected as an ordinary member and Mrs. Lovegrove as an associate. The Secretary read Dr. Simpson's report on an excursion to Gingin, held on September 13th. Mr. Foldtmann exhibited a collection of fossils obtained at the excursion, and pointed out that they proved the formation to be of Cretaceous, and probably Upper Cretaceous, age. Mr. Herbert read a report on an excursion to Lake Yangebup held on September 27th. In view of the proposed lease of Bernier and Dorré Islands, it was decided to urge the Government to keep the islands as a reserve for native game, and the council was instructed to act accordingly. Mr. Alexander then read a paper on Lampreys. Mr. D. A. Herbert read a paper on the Climbing Habits of the Narrow Mouthed Lamprey, the result of observations made by him in February, 1919, on the Beedelup Brook.

11th November, 1919: The President, Mr. G. L. Sutton, in the Chair. Mr. Hall gave a report on an excursion from Swan View to Darlington, and Mr. Alexander reported on an excursion to Lesmurdie Falls. Revisions of the existing rules were put to the meeting and carried. Mr. Gibb Maitland, on behalf of Mr. E. de C. Clarke, read a paper on "The Occurrence of Boulders near Leonora and Laverton," believed to be of glacial origin. Mr. Gibb Maitland stated further that Mr. H. W. B. Talbot had met with similar conglomerates along the Ponton River. Similar boulder clays were met with in the Wilkinson Range in South Australia and in bores on the Nullarbor Plain, and this pointed to a very wide extent of glacial deposit.

9th December, 1919: The Vice-President, Dr. E. S. Simpson, in the Chair. A letter from the Lands Department was received in which it was stated that the Minister did not see his way clear to reserve Bernier and Dorre Islands. On the motion of Mr. W. J. Hancock, it was decided to ask the Lands Department to inform the Society as to the name and address of the lessee of the islands so that the Society might lay its views before him. Dr. Lovegrove, Dr. Lotz, and Mr. Herbert were elected to the Council, owing to the operation of the rule which, by declaring ex-presidents *ex-officio* members of the council, had created three vacancies. In the absence of Mr. Herbert, his report on the excursion to Greenmount on November 15th

was read by the Secretary. Mr. Alexander then gave a report on an excursion to Garden Island on November 15th. The Secretary read a paper by Mr. D. A. Herbert, on "*Xanthorrhoea reflexa*, a new species of blackboy," and a paper by Mr. Edwin Cheel on a new species of *Daviesia*. Mr. Alexander read a paper on "Aboriginal Names of Animals in the Lyons River District." He also exhibited a specimen of the Soft-plumaged Petrel (*Æstrelata mollis*) from Cottesloe, the first specimen obtained in Australia. Dr. Simpson exhibited specimens of Fontainebleau sandstone from Minilya River, and showed specimens of quartz and lithia mica in which luminescence could be produced by friction and sudden cleavage respectively.

9th March, 1920: The President, Mr. G. L. Sutton, in the Chair. Mr. M. Aurousseau, M.C., B.Sc., and Mr. S. K. Montgomery, B.A., B.Sc., were elected ordinary members. Mr. Edwin Cheel, of the Sydney Botanic Gardens, was elected a corresponding member. Dr. Simpson exhibited specimens of ferro-silicon and of pucherite (vanadate of bismuth). The former is frequently mistaken for a mineral. The latter was from Westonia and is recorded for only seven other localities, one being Niagara in this State. It occurs in canary yellow streaks in pegmatite veins. Mr. D. A. Herbert read a paper on "Confusion between three species of Western Australian Acacias," dealing with *A. cyclopis*, *A. saligna* and *A. cyanophylla*. Mr. G. L. Sutton read a paper on "Relation of Moisture Content of Wheat to Atmospheric Humidity." Mr. H. B. Curlewis read a paper on "Recent Work on Australian Longitudes," outlining the work done and work still remaining to be done.

13th April, 1920: The President, Mr. G. L. Sutton in the Chair. Mr. Allum announced on behalf of the Council that it had been decided to present an address of welcome to the Prince of Wales on the occasion of his visit to the State. Mr. D. A. Herbert exhibited specimens of *Podocarpus Drouyniana*, a native conifer, in fruit, and showed a fungus *Xylostroma gigantea*, hitherto unrecorded for this State. Mr. S. K. Montgomery read a paper on "*Hymenosomidae* from Western Australia." Dr. Simpson read a paper on "Occurrence of Cobaltiferous Epsomite at Parkerville," as an efflorescence on the chlorite rock of the municipal quarries. Mr. M. Aurousseau read a paper on "Influence of External Attraction on the Prismatic Compass," the outcome of observations made in the battlefields of France.

11th May, 1920: The President, Mr. G. L. Sutton, in the Chair. Mr. A. Gibb Maitland exhibited a specimen of sandy limestone from below the coal measures in a bore at Collie. The Secretary read a paper by Mr. J. Clark, on "Ant-Nest Beetles in Western Australia." Mr. Herbert read a paper on "Contributions to the Flora of Western Australia," containing a description of a new species, *Isopogon occidentalis*, and records of plants not previously recorded from this State.

29th *May*, 1920: The Annual Conversazione was held at the University. There was a large attendance of members and guests and the following exhibits were shown:

By Professor Ross: Lunar and time charts, galvanometers, and other physical apparatus.

By the Biology Department of the University: Models of plant and animal structures, and a demonstration of the making of microscope slides by Mr. S. K. Montgomery.

By Dr. Simpson: (1) Fuller's Earth from Collie: (2) An exhibit showing the relation between "body" of a white paint and the refractive index of the pigment: (3) A collection of natural pigments (ochres, etc.), from within the State.

By Mr. G. L. Sutton: Wheat varieties, flax, and linseed raised in Western Australia.

By Mr. J. Clark: Ground weevils and other coleoptera.

By Mr. L. J. Newman: Destructive insects.

By Mrs. A. Montgomery: War relics.

By Mr. A. Knapp: Photographs.

By Mr. D. A. Herbert: Poison plants, insectivorous plants, parasites, xerophytes, and an insect-catching orchid.

8th June, 1920: The President, Mr. G. L. Sutton, in the Chair. Mr. Galbraith and Miss Hussey were elected ordinary members. The discussion of Mr. Clark's paper on "Ant-Nest Beetles in Western Australia" was continued, and Mr. Galbraith, Dr. Simpson, and Mr. Grasby commented on it. Professor Ross read a paper on "Einstein's Theory of Relativity and New Ideas regarding Space and Time."

July, 1920: The Vice-President, Dr. E. S. Simpson, in the Chair. The Vice-President apologised for the unavoidable absence of the President and the necessary postponement of delivery of the Presidential Address. The Annual Report was read by the Secretary and adopted. The Treasurer's statement, duly audited, was adopted. The Vice-President announced that the following nominations of office-bearers had been made by the Council: –

President Dr. E. S. Simpson.
Vice Presidents Mr. C. E. Lane-Poole and Mr. F. E. Allum.
Hon. Treasurer Miss Enid Allum.
Hon. Librarian Mr. W. E. Shelton.
Hon. Secretary Mr. W. B. Alexander.

As the result of a ballot the following were elected members of the Council: Miss Creeth, Dr. Lotz, Dr. Lovegrove, and Messrs. Saw and Herbert. Mr. Glauert exhibited specimens of the soft-plumaged petrel (*Pterodroma mollis*, Gld.), a rare winter visitor found at Cottesloe, and the Cape Pigeon (*Daption capensis*) now recorded for the first time from W.A. The Secretary then read a paper for Mr. Edwin Ashby, F.L.S., on "The Occurrence of three species of Stenochiton in Western Australia," being notes on specimens collected at Garden Island last year by Mr. Alexander.

LIST OF DONORS TO THE LIBRARY.

Australasia—

W. B. Alexander, M.A., Museum, Perth.
Commonwealth Bureau of Census and Statistics.
Department of Agriculture, S.A.
Department of Agriculture, N.S.W.
Field Naturalists' Club of Tasmania.
Field Naturalists' Club of Victoria.
Royal Societies of Queensland, New South Wales, Victoria, Tasmania, South Australia.
Geological Survey of Western Australia.
Field Naturalists' Club of South Australia.
National Museum, Melbourne.
Commonwealth Advisory Council of Science and Industry.
Geological Survey of Tasmania.
Australian Museum, Sydney.
J. H. Maiden, Esq., Director Botanic Gardens, Sydney.
Linnean Society of New South Wales.
Technological Museum, Sydney.
Queensland Museum, Brisbane.
New Zealand Board of Science and Art, Wellington.
Government Bureau of Microbiology, Sydney.
National Park Board of Tasmania.
Hon. Minister for Home and Territories, Melbourne.
C. Hedley, Esq., Australian Museum, Sydney.

Asia—

Botanic Survey of India.
Department of Agriculture, Industry, and Commerce, Buitenzorg, Java.
Geological Survey of India.

Europe—

Royal Colonial Institute.
Royal Botanic Gardens, Kew.
British Museum of Natural History.
Secretary of State for India in Council.
Secretary of State for Colonies.
Imperial Institute.
Philosophical Society, Cambridge.
Museum National d'Histoire Naturelle, Paris.
Societe Royale de Botanique de Belgique, Bruxelles.
International Institute of Agriculture, Rome.
Bergens Museum, Norway.
Académie Royale des Sciences, des Lettres et des Beaux-arts de Belgique, Bruxelles.
Junta de Ciencies Naturals de Barcelona.

Africa—

H.M. Astronomer, Cape of Good Hope.
Durban Museum, Natal.

America—

Royal Society of Canada.
Geological Survey of Canada.
Smithsonian Institute.
U.S.A. Department of Agriculture.
U.S.A. Geological Survey.
John Crerar Library.
University of Minnesota.
University of Nebraska.
University of Illinois.
University of California.
University of Maine.
Missouri Botanical Garden.
Academy of Natural Sciences of Philadelphia.
C. C. Lloyd Library.
Field Museum of Natural History.
American Museum of Natural History.
Cuerpo de Ingenieros de Minas del Peru.
American Society for International Conciliation.
John Hopkins University.

SCIENCE AND AGRICULTURE.

A POST WAR OPPORTUNITY FOR THE DEVELOPMENT OF THE AGRICULTURAL RESOURCES OF W.A.

PRESIDENTIAL ADDRESS

BY

GEO. L. SUTTON,

Agricultural Commissioner for the Wheat Belt.

(*Delivered 10th July*, 1920.)

On this, the occasion of the last phase of my activity as President of your Society, I desire to thank the members and particularly my colleagues on the Council for the loyal and hearty support which they have afforded me during the past year, and which has rendered my duties so pleasant.

Though my remarks, regarding the opportunity which presents itself to Western Australia because of the world shortage of foodstuffs, apply to Agriculture generally, yet following a recognised custom I have more particularly dealt with that branch of Agriculture, viz., wheat growing with which I am working and am therefore more familiar.

In his presidential address to the British Association for the Advancement of Science, Sir Wm. Crookes in 1898, startled the civilised world by pointing out that the consumers of wheat were in crescendo progression and by forecasting that, as the world's available wheat lands were known, the consumption of wheat would overtake the supply by 1931, and unless the world's average yield could be increased, principally by the adoption of a system ensuring the more liberal application of nitrogenous manures, the visible supply of which was also within sight of exhaustion. The prediction was made upon the most reliable data then available, but Science ever ready to respond to the stimulus of need, has extended the date when the event anticipated by Sir Wm. Crookes would have occurred under normal conditions. In making his estimate, Australia as a wheat producing country was regarded as a negligible factor because of its uncertain seasons. In this connection the wheat production of the States other than South Australia was regarded as so uncertain "as to cause Europeans to wonder why the pursuit of wheat growing is continued."

Though the seasons are not more regular and droughts still occur, the wheat crop is not nearly as uncertain as formerly and

once only during the past ten years has the Australian crop been insufficient for local needs. Even in that season 1914-15 of exceptional drought, over 650,000 tons were produced and in the succeeding year, consequent upon a special effort to meet the war needs of the Empire, combined with a satisfactory rainfall, a record yield of nearly four and three-quarter million tons was produced. Despite its climatic uncertainties, the volume of wheat produced in Australia has so increased that its production is now an important factor in the world's trade to the extent of some one and a-quarter million tons annually. This has been brought about largely as the result of the scientific production of new and more suitable varieties of wheat and the adoption of sound scientific methods of manuring and tillage.

Nor need the exhaustion of the world's supply of nitrogenous manures any longer be feared. This is also due to scientific discoveries by means of which the illimitable free atmospheric nitrogen can be fixed and made available for our needs. The supply of nitrogen from this source is now available commercially as "Nitrolin" and kindred manures, and in these the world has received from Science a gift of inexhaustible extent.

Though the permanent shortage of wheat as feared by Sir Wm. Crookes has been postponed indefinitely, yet the civilised world has temporarily reached the position forecasted by him. To-day there is not enough wheat in the world to meet its needs. This position is the natural corrollary of the great war which has caused the absolute depletion of the world's supply and reserves of wheat. This shortage of wheat has also created an unusual demand for other foodstuffs in lieu thereof, until at present there is in Europe such a general shortage of foodstuffs as has never before been experienced. The extent of the shortage of all foodstuffs can be best illustrated by the position with regard to wheat, as this is the most important article of foodstuffs dealt with in international trade, and in that connection it is also the foodstuff of greatest importance to Western Australia. It is quite true that four years of the most devastating war the world has ever known, have thrown all cereal statistics into the melting pot, yet a very good idea of the position can be obtained by studying the statistics for the quinquennial period preceding the war—and this despite the fact that during the war some wheat producing countries harvested abnormally large crops. This was offset by the fact that in other countries there were total or partial failures. In a bulletin, "The World's Supply of Wheat and other Cereals," published by the International Institute of Agriculture (March, 1915), Sir James Wilson shows that the world's average annual production of wheat for five years (1909–1913) preceding the war was 1,059,200,000 quintals (104,000,000 tons) and of this amount the principal belligerent nations engaged at the commencement of the war produced 484,400,000 quintals (47·6 million tons). Details of this production

are set out in the table hereunder, which also shows the net imports and net exports of each country : —

Wheat Production—Imports and Exports of Belligerent Nations.

	Production.	Net Imports. Millions of tons.	Net Exports.
Germany	4·07	1·83	...
Austria	1·63	·28	...
Hungary	4·54		
Belgium	·39	1·32	...
France	8·49	1·17	...
Bulgaria	1·22	...	·28
Great Britain	1·59	5·77	...
Greece	·12	...	...
Italy	4·90	1·42	...
Roumania	2·35	...	1·43
Russia	17·12	...	4·39
Poland	·61	...	...
Serbia	·36	...	...
Turkey	·19	...	...
Total	47·58	11·79	6·10

From these figures it will be seen that in normal peace times the nations then at war required to import over 5½ million tons in order to meet their consumption demands.

Though, throughout the war, each belligerent nation maintained its agricultural productions at the highest possible level compatible with the maintenance of its fighting strength, and Great Britain as the result of splendid organisation actually produced more wheat during the later years of the war than during a similar pre-war period; yet with the enormous number of men under arms and the devastation occurring, especially in France and Belgium, it was impossible that the other belligerent nations should do likewise. Since the conclusion of the war we have learnt definitely that the production has been far indeed below the pre-war level. There was therefore greater need to augment the local supply in the belligerent countries during the war than prior to it. The supplies to the allies from overseas were maintained, but owing to the effective blockade maintained against enemy countries, very little if any went to them. In consequence, the European granary has been found to be bare to the boards and the people in enemy countries are not only hungry, but actually starving for bread.

The position is the more serious in that there are no wheat reserves stored in countries remote from the war to draw upon, for it has been quite impossible to build these up. Using again the figures available for the quinquennial period 1909–1913, it is found

that the average annual quantity of wheat available for export by countries remote from the war was —

Average Export of Exporting Countries, Remote from War, five years 1909–1914.

	Millions of tons.
United States	2·46
Canada	2·18
Argentine	1·91
Australia	1·23
India	1·14
	8·92

Even if their production during the war time had been maintained on a pre-war level, the Allies would have required to import as follows :—

	Millions of tons.
Belgium	1·13
France	1·00
Great Britain	4·98
Italy	1·23
Total	8·34

or 0·6 million tons less than is normally available from exporting countries remote from the scene of war.

Consequent upon the ravages of war and with the greatly decreased production, though of unknown extent, occurring in Belgium, France, and Italy, the imports required to meet their needs during the years of the war period have been obviously much greater, and in consequence the whole of the surplus of wheat exporting countries remote from the scene of conflict has been more than required by the Allies and neutrals, and there are therefore no reserves except those of Russia, a doubtful and unknown quantity.

The unprecedented shortage of foodstuffs in Europe is regarded as one of the fundamental causes of the many difficult post war problems, including industrial unrest with which the world is faced. The great need to-day is therefore the replenishment of the world's food supply.

In common with the other States of the Commonwealth, the world's great need for agricultural produce is the *opportunity* of Western Australia to develop its agricultural resources quickly

and profitably. The unprecedented demand for foodstuffs postulates high rates for all kinds of agricultural produce, and these are likely to be above normal for some years. Not only do the pressing immediate needs require to be met, but those reserves which have been exhausted and which are so economically essential for the welfare of nations, have to be replaced before the European granary can be said to be in a normal condition again.

Our agricultural resources can be developed in the following ways :—

(*a.*) By bringing new lands of recognised agricultural value into cultivation.

(*b.*) By the profitable reclamation and utilisation of areas at present considered unprofitable for agricultural production.

(*c.*) By improvement in our methods so as to increase the production of the land already under cultivation.

The bringing of new lands of recognised agricultural value into cultivation calls only for that business organisation and effort which has been so tremendously successful in settling the wheat lands of the State since the beginning of the century. How successful this has been is shown by the fact that at the beginning of the century the State produced 774,000 bushels of wheat -not sufficient for its own requirements, and in 1915-16 its production was 18,236,000 bushels, and over 14,000,000 more than was required within the State.

As in all other agricultural countries, so in W.A. there are lands which are considered unprofitable for agricultural purposes. This may be because they are—

(*a.*) Of poorer quality than those in general cultivation, or

(*b.*) Located outside what at present are regarded as favourable climatic conditions.

If the agricultural resources of these lands are ever to be developed it must be done by the application of the teachings of Science to the agricultural methods adopted for their cultivation. It may be that the special problems of Western Australia in connection with these lands will require that research work be conducted in order to ascertain the principles underlying them. It is, however, believed that our great need at present, is to take advantage of the research work already done elsewhere and to apply it here. This can only be done by trials or experiments. Experiment Farms are needed therefore to learn how to apply to both types of land the facts and laws already known. The need is particularly great in connection with the development of our light lands. To develop these we need especially to ascertain how the known laws relating to soil improvement can be applied and how to produce fodder and other crops peculiarly adapted for them.

A notable instance of what has been done in connection with the reclamation of land outside of what, at one time, were regarded

as suitable climatic conditions for wheat production, is the extension of the wheat lands of the world as the result of the adoption of " dry farming " methods, in other words the adoption of scientific methods of tillage to conserve moisture. In our own State the wheat belt has been extended in this way to the 10-inch isohyet. The Experiment Farm at Merredin on that line has shown that wheat growing is quite safe there, and Science ever progressing and unable to stand still is now asking whether the line cannot be extended still further eastward.

Already this problem is being attacked in Mesopotamia with an annual rainfall of less than seven inches and with much less relative humidity than in Western Australia. Success hinges upon methods which apply scientific principles to the conservation of soil moisture and the development of early maturing varieties of wheat. We are not less resourceful than our kinsmen who are attacking this problem in Mesopotamia. Our conditions are more favourable, our prospects are therefore brighter. The time is in consequence, opportune for the establishment of an Experiment Farm outside the area in this State are present considered safe for wheat cultivation.

From time immemorial agricultural problems have proved complex and full of pitfalls even for men of the mental calibre of Boyle, Davy, and Liebig. Those now to be dealt with will be equally as complex and as full of pitfalls as when the principles underlying the Science of Agriculture were being established, unless those entrusted with their solution have been trained regarding these principles and have been made familiar with the most recent knowledge of the subject. It is therefore essential that the solution of the agricultural problems confronting us shall be entrusted only to those who have received a sound scientific training in the principles of Agriculture, otherwise misleading deductions a e likely to be made and erroneous theories likely to be propounded. Trained men are therefore required to take charge of these Experiment Farms.

Though considerable development of new lands will take place in the future, it is not to be expected that production in the future will bear the same relation to the opening up of new lands as it has done in the past. A considerable acreage of the new lands will be required to replace the older lands and take their place for stock feeding and other purposes in the farm rotations as the pioneering stage passes. As our new lands become settled, more and more each year will increased production depend upon better methods. Just as the application of principles of Science to the practice of Agriculture will enable us to develop the resources of the areas at present considered unprofitable for agricultural production, so the productivity of the lands already under cultivation can be increased also by the more general adoption of such a plan.

There are those who still maintain that successful farming requires only common sense, muscle, and machinery, and that Science applied to the most ancient of arts is still theoretical, and has little to do with the business of life. The number is, however, rapidly diminishing, and the value of Science as applied to Agriculture is receiving general recognition. It is especially valuable in new undeveloped countries like our own without centuries of experience to guide us. Its aid is absolutely essential if new methods are to be on a sound basis. Amongst the many things Science has taught agriculturalists, a few are :-

How to produce new varieties.
How to improve existing varieties of plants.
How to transform dormant manures into quickly acting ones.
How to conserve soil moisture.
How to utilise the inexhaustible supply of atmospheric nitrogen.
How the organic matter of the soil may be increased.
How plants obtain their food from the soil and from the air.
How to combat plant and insect pests.
How to feed stock on economic principles.

As the result of such teachings, the soil can be made to produce prolifically and continuously, unfavourable climatic influences are minimised, and the great losses caused by insect and other pests lessened.

The classical example of the economic benefits resulting from the application of the principles of Science to Agriculture is the increased production which took place in Germany during the 25 years 1888 to 1913, without which it would have been quite impossible for that nation to have continued in the war as long as she did. The increase is shown in the following table :

Table showing the Production of Farm Produce and Live Stock in Germany in 1888 *and* 1913.

Crops.	1888.	1913.	Increase.	Decrease.
	Millions of bushels.	Millions of bushels.		
Wheat	103	171	68	...
Oats	243	669	426	...
Barley	97	168	71	...
Rye	262	481	219	...
Potatoes	950	1,988	1,038	...
Stock (in thousands)— ...				
Horses	2,420	4,523	2,103	...
Cattle	8,740	20,182	11,442	...
Pigs	5,820	22,100	16,286	...
Sheep	14,750	5,803	...	8,947

*Year Book of U.S.A., Department of Agriculture, 1915.

Assuming that one horse or cow is equivalent to eight sheep, and one pig to one sheep, the total increase of live stock is equivalent to 114,000,000 sheep.

In an article dealing with the recent development of German Agriculture, 1888–1913, Mr. T. H. Middleton, Assistant Secretary to the British Board of Agriculture points out *—

> "It is shown that the area of cultivated land in Germany has slightly decreased in recent years. The reclamation of moorland about which we hear much, is interesting as an indication of agricultural energy, but it counts for little in the feeding of the German people. The agricultural population has remained practically stationary. Rather less, than more labour is being employed now than twenty-five years ago. It is, indeed, evident that the larger production has not been due to an increase in the area tilled, or to an increase in the number of persons engaged in tillage, but to better farming, the soil has been better cultivated, crops have been more skilfully manured, plants and animals have been improved in type, the use of oil cakes and other feeding stuffs has increased, sanitary laws have led to a great improvement in the health of farm live stock. Side by side with these improved technical methods, improved business methods have been resorted to and the profits of agriculture have in turn been employed in further developing the means of production."

From this it will be seen that the remarkable increase in German crop production and live stock farming is not due to increased acreage under crop, nor to greater numbers engaged in Agriculture, but to the increased efficiency of their farming methods. This point is confirmed by a comparison of the average yearly yields of cereals, hay, and potatoes during two quinquennial periods occurring in a period of twenty-five years.

Table showing yearly average Yield per Acre of Cereals, Hay and Potatoes in Germany during a Period of 25 Years :—

	Yield per Acre per Annum	
	1888 1889	1903–1913
Wheat, bushels	19·8	31·6
Barley ,, ...	22·7	36·7
Oats ,, ...	25·7	44·6
Meadow Hay, cwt.	22·5	33·7
Potatoes, tons	3·4	5·4

Such remarkable results are illuminating and should be inspiring. They are sufficient to warrant that nothing shall be

*Journal of the Board of Agriculture, 1916.

left undone to bring about more general adoption of the latest scientific teaching to the practice of Agriculture.

Consequent upon the number of the world's agricultural workers, scientific progress in Agriculture has never been as rapid at any period as at present, and it is believed that if the most advanced methods were generally adopted by the majority of our farmers, our production per acre would increase at least fifty per cent.

A local writer has recently stated: "Rapid progression in the application of scientific discovery to practical purposes is now a world wide rule." Unless, therefore, steps are taken to ensure that the scientific discoveries made in connection with agricultural science are promptly applied to agricultural practice then agriculture lags behind the other arts in their up-to-date plan of taking advantage of scientific discoveries.

The general adoption of the latest scientific teaching to the practice of Agriculture, and the resultant increase in the agricultural output of the State, can best be brought about by a scheme of agricultural education, for as one writer states: —

> "The man power is the real measure of efficiency in production, rather than acre yields, and the increase in this efficiency rests upon the spread of education. To raise the scale of production, there must be a higher level of education among the mass of farmers to bring up those below the average and to raise the average up to the better ones."

The scheme of agricultural education adopted should provide for—

(*a.*) The training of young people in the scientific principles underlying the practice of Agriculture.

(*d.*) The dissemination of agricultural information amongst adults.

The scheme of Agricultural Education in this State is on an excellent basis, but requires elaboration and extension. It commences in the primary schools and continues with its apex at the University. In the rural primary schools it is very properly limited, so that it is unspecialised, and it is utilised in as far as it, as a Science, can be applied to the general education of the pupil. It is of special interest and value in these schools because of its association with the environment of the scholars. Elementary Agricultural Science is also taught in the District High Schools, in some Secondary Schools and at the Narrogin School of Agriculture. From these schools the student can proceed to the more advanced scientific training at the University.

At the Narrogin School of Agriculture practical tuition in the art of farming is given in addition to the training in Agricultural Science. It is the only specialised institution of its kind in the State. It is a junior institution with a two years' course, and

has a total accommodation for forty students whose ages range from 14 to 18. The facilities available are totally inadequate to the needs of this State, containing as it does some 8,000 wheat growers in addition to fruit growers, and other farmers. It is at this specialised stage that our system of agricultural education is weakest. The School of Agriculture at Narrogin has already done excellent work. Its accommodation requires enlarging and its equipment improving. In addition, provision for a senior or diploma course requires to be made at an associated but senior institution for it is the specialised courses, junior and senior, which have for their object the training of educated practical farmers. The Professor of Agriculture, in order to meet the needs in this connection has done what was possible and has established a diploma course at the University. The disadvantage of this is that it is non-residential. The University provides a degree course in Agricultural Science and it is this course which provides for the training of research workers, agricultural teachers, and agricultural advisers and field officers of the future. The course is sufficient for this purpose if utilised. A similar course is provided in most of the other State Universities, but enrolment has always been small. This condition is attributed to the restricted field now open to University Graduates in Agriculture.

In addition to providing the useful graduate course it is believed that the University can with advantage to the State, take a special interest in its agricultural problems and that after the requirements of a full and broad general education are satisfied, the general activities of the University can well centre around the Chair of Agriculture because of the relation which it should bear to, and the connection it should have with, one of our principal primary industries. The growth of plants has interested the thinking men of all ages. Is it too much to expect that the scientists at the University specially interested in our local problems shall take special interest in this matter now that the problem is one of vital economic importance not only to the State, but also to the Empire ?

The dissemination of agricultural information amongst farmers is carried out by means of peripatetic lectures and demonstrations by specialists of the Department of Agriculture, by University extension lectures, and by the free distribution of bulletins relating to agricultural matters of topical interest. The need of this phase of agricultural education is great in any new country, but it is greater in this State where the ranks of agriculturalists are recruited from all sections of the community and not principally from those with a previous connection with the land. How great is the need for the dissemination of up-to-date agricultural information, may be gauged from the fact that the deficiencies of the original theories of Liebig and others regarding soil and plant analyses are still extant.

The work of spreading the latest information amongst farmers, and thus providing facilities for maintaining their technique at the highest possible level, will call for an increasing number of skilled specialists, preferably of university rank. The need of the present is, and the greater need of the future will be therefore, scientifically trained men. They are required as reachers of Agricultural Science, Officers of Experiment Farms, Field Officers, and Inspectors in order that the fullest development of our agricultural resources may take place as the result of the application of the principles of Science to the practice of Agriculture. The trained men necessary can be turned out by most of the Australian Universities, which have been offering courses in Agriculture for several years past. The enrolment has always been small, largely because of the restricted field now open to University Graduates in Agriculture. Because of the usefulness of these Graduates to the State, the field should be widened, and it is not unreasonable to assume that this State which has made such a huge success of settling its lands, will also make satisfactory provision for training the necessary men when it realises how necessary they are in order to develop the settled lands.

Thanks very largely to the foresight of the late Sir Winthrop Hackett, by whom the Chair of Agriculture was endowed at the West Australian University, the facilities for training the men required are available in this State. Unfortunately, great as is our need, the fullest advantage is not being taken of them. This will only be done when the State, which properly controls the needed experimental work, undertakes to train the officers required. The State of New South Wales has found it advantageous to adopt this course and has established a system of cadetships, by which some of its officers have been and others are to be trained. Victoria is adopting a similar course and has undertaken to find positions at remunerative salaries for six graduates in Agricultural Science each year during the next five years.

If West Australia is not to lag behind in the race for agricultural development, it is imperative that she should adopt a similar course. With greater interests than other states in rural activities requiring Agricultural Advisers and Land, Bank, and other Agricultural Inspectors, the need in this State for trained men is greater. It is believed that the most suitable method is to establish a system of cadetship which will provide for training yearly in the Diploma or Degree Course of at least five men who would become available for new positions such as Experiment Farm Officers, Plant Breeders, and Agricultural Advisers, and to fill vacancies as they occur in the ranks of Land, Bank, and other Inspectors.

The benefits of applying the principles of Science to the practice of Agricultural are tangible and real. They are not always appreciated. The value of such a plan following upon the result of a well organised system of Agricultural Education is illustrated by

the German experience when their crop production was increased by £120,000,000 in twenty-five years and the value of the live stock was increased from £320,000,000 in 1892 to £660,000,000 in 1914. Professor Von Rumken, of Berlin, thus summaries the German view of Agricultural Education—

> "The great progress that Agriculture has achieved in Germany during the last quarter of a century is the result of the Union of *Practice* with *Science* and proves that money spent on reasearch and on education in every class brings in a huge rate of interest and is compensated for by increase in land taxes and of revenue from State Railways."

Not only is there a strong material advantage to be gained by the development of our agricultural resources, there is in addition a strong moral obligation to develop the wheat lands of this State. With the number of wheat eaters throughout the world gradually but persistently increasing, the available harvest fields are by no means too extensive for its needs. Not to develop our harvest field, small comparatively though it is, is to shirk our responsibilities. This is especially so as the wheat produced under our climatic conditions is of exceptionally fine quality. As one writer (Hugh R. Rathbone, Staple Trades of the Empire), says of Australia, "It is perhaps the finest wheat in the world and from the point of view of consumption has only one drawback -the long voyage." British millers find Australian wheat valuable for improving the keeping qualities of their own locally grown wheat. It is also useful for imparting colour and bloom to the flour made from British wheat. There are therefore International and Imperial reasons as well as a material and selfish one for the speedy development and extension of the wheat lands of Western Australia.

From time to time more or less well informed visitors have taunted Australians because of the frequent use made of the word potentialities. Because of the low esteem in which Australia and its products were formerly held, Australians in the past were compelled to draw attention to the immense dormant wealth of our continent by talking about it. Since the war the world has had reason to believe in our potentialities. It is necessary therefore no longer to talk about them: it has become our duty to develop them. The need for developing our agricultural resources is urgent and the scientist is called upon to co-operate with the agriculturalist in a joint effort. The need for this co-operation was recognised by the late King Edward, who at the opening of the buildings of the University of Leeds in 1908 thus expressed himself—

> "It is a source of pleasure to me to know that you have provided also for the study of the theory and practice of Agriculture, for I am convinced that the best possible results cannot be derived from the industry and natural ability of our farmers unless they are properly instructed in the scientific aspects of their work."

CONFUSION BETWEEN ACACIA CYANOPHYLLA, A. SALIGNA, AND A. CYCLOPIS.

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(*Read 9th March*, 1920.)

These three phyllodinous acacias are native to South Western Australia, but have been planted to a large extent in other countries, particularly South Africa. A great deal of confusion exists as to the separation of the three species, as all three seem to have been exported under the name of *Acacia saligna*. This species is relatively scarce, and a great deal of reputed *saligna*, in the Eastern States at any rate, is *A. cyanophylla*. Dr. Perez, of Teneriffe, writing to Mr. Lane-Poole, the Conservator of Forests, says that great confusion exists at the Cape about this species. He sent specimens numbered from 7 to 14 of reputed *Acacia saligna* to Mr. Maiden, the Government Botanist of New South Wales, who named them all *Acacia cyanophylla*, Lindl.

These two species are very similar and are rather hard to separate, but the third, *Acacia cyclopis* is easily distinguished. *Cyanophylla* and *saligna* belong to the Uninerves, characterised by the one central nerve of the phyllode, with some times a fainter and smaller one, whereas *A. cyclopis* belongs to the Plurinerves, the distinguishing feature of which series is the several longitudinal nerves of the phyllode. In addition the seed of the latter possesses a large red aril encircling the seed in double folds (*see* Plate). The description is as follows :—

> *Acacia cyclopis.*—A. Cunn. in G. Don. Gen. Syst. ii., 404.—A shrub of six to ten feet usually glabrous with anuglar, branchlets. Phyllodia narrow-oblong, nearly straight obtuse, narrowed at the base, one and a-half to three, rarely four inches long, rigidly coriaceous, with three to five nerves and anastomising almost longitudinal veins. Peduncles solitary or two or three in a short raceme, bearing each a dense globular head of numerous flowers, mostly 5-merous. Calyx turbinate, shortly lobed or toothed, more than half as long as the corolla. Petals smooth, free, pod flat, and four to six lines broad as in *A. melanoxylon* but more coriaceous curved or twisted, seeds nearly orbicular ; funicle thickened and richly coloured from the base, encircling the seed in double folds—Bentham, *Flora Australiensis*, Vol. II., p. 388. Localities : King George's Sound, Swan River, Preston River.

The confusion of this species with the others is on account of inaccurate naming by seedsmen and not because of any real affinity to them. *A. cyanophylla* and *A. saligna*, however, are rather difficult to separate from one another. They are both very similar in habit, foliage, flowers, and seed pods, but there are small differences which distinguish them readily.

The descriptions as given by Bentham (Fl. Aust. II, 364), are as follows :—

Phyllodia more or less prominently penniveined—*A. cyanophylla.*

Phyllodia smooth, the veins scarcely conspicuous. *A. saligna.*

A. saligna.—Wendl. Comm. Acac. 26.—A tall shrub or tree quite glabrous, with angular branchlets. Phyllodia falcate-lanceolate, rather obtuse, much narrowed towards the base, many inches long, rather thick, one-nerved, obscurely or rarely more distinctly penniveined, with nerve-like margins, the marginal gland distinct from the base often wanting. Racemes short with few globular heads, larger than in the preceding six species, the rachis rather stout and flexuose. Flowers about 25–30 in the head, often slightly pubescent, mostly pentamerous. Calyx not half so long as the corolla truncate or sinuate toothed. Petals smooth, pod flat often five or six inches long, usually straight, scarcely three lines broad, not at all or slightly contracted between the seeds. Seeds oval oblong, longitudinal. Funicle short, gradually thickened almost from the base into a club-shaped fleshy aril. Localities : King George's Sound, rare, R. Brown ; to the Eastward, Baxter ; towards the Great Bight, Maxwell.

Acacia cyanophylla.—Lindl, Bot. Reg. 1835. Misc. 49.—A tall handsome shrub glabrous and often more or less glaucous, emitting at least in cultivation suckers from the roots, branches scarcely angular. Phyllodia from linear oblong to lanceolate falcate, the lower ones sometimes over a foot long, the upper ones half a foot or less and narrower, much narrowed towards the base one-nerved penniveined, with nerve-like margins, the marginal gland obscure or none. Racemes short with 3–5 heads of numerous (above 40) flowers mostly 5-merous, the common rachis rather stout and flexuose, the peduncles 3–6 lines long, sepals cohering to the middle in a tubinate lobed clayx. Petals smooth but with prominent midribs. Pod several inches long, flat, 2 to $3\frac{1}{2}$ or rarely three lines broad, contracted between the seeds. Seeds oblong, longitudinal, funicle as long as the seed, the last fold slightly thickened into a somewhat clavate aril with very short folds below it. Localities : Swan River.

These descriptions require a very slight alteration.

Some specimens of *Acacia saligna*, collected by Oldfield and Maxwell, were obtained from the National Herbarium of Victoria through the courtesy of Professor Ewart, and I have also examined a large number of specimens collected personally. The only alteration to the description of *A. saligna* is with regard to the pods. The original description says "not at all or slightly contracted between the seeds." Many specimens including Oldfield's are distinctly contracted between the seeds. The description of *A. cyanophylla* says "branchlets slightly angular"; in many cases the branchlets are very prominently angled, especially in young plants. Again it says "Racemes short with 3–5 heads of numerous (above 40) flowers." A great many specimens contain up to nine heads in a raceme.

Both species are very variable, and are frequently indistinguishable in foliage and habit. The principal differences are tabulated below: —

Character.	*Acacia cyanophylla.*	*Acacia saligna.*
Size ...	Tall shrub	Tree or shrub
Leaves ...	Glabrous and glaucous more distinctly penniveined than in saligna and the younger leaves long	Glabrous
Flowers ...	About 40 in a head	Twenty-five to thirty in a head
Calyx ...	Half or a little more than half as long as corolla, turbinate, lobed	Not half as long as corolla
Corolla ...	Petals with midrib	Petals without midrib
Seeds ...	Funicle long, folded with the last fold thickened	Funicle short, gradually thickened from the base, so as to be clavate

Distribution of the Species. —*Acacia cyanophylla* is a Swan River species. It is common all round the coast and along the river, and has been collected at Cranbrook in the Stirling District by Diels and Pritzel. *Acacia saligna*, on the other hand was originally described from King George's Sound, and there is no record of its having been obtained further north. I have, however, collected it on the Swan River, growing amongst *A. cyanophylla*, at Crawley and Applecross, and by the Helena River at Greenmount. Its similarity to the common species has probably been the reason why it has been overlooked.

Acacia cyclopis is common round the coast from the Swan River to the Bight. It does not go inland.

A.—*Acacia saligna.*
1. Leaf and cluster of pods showing seeds.
2. Seeds, natural size.
3. Aril, magnified.

B.—*Acacia cyanophylla.*
4. Leaf showing secondary nerve.
5. Leaf not showing secondary nerve.
6. Seed, natural size.
6a. Aril, magnified.

C.—*Acacia cyclopis.*
7. Leaves.
8. Pod.
9. Seed with aril (p.—point of attachment).

THE ABSORPTION OF MOISTURE BY WHEAT GRAIN AND ITS RELATION TO THE HUMIDITY OF THE ATMOSPHERE.

By GEO. L. SUTTON, Agricultural Commissioner for the Wheat Belt.

(*Read 9th March*, 1920.)

In the commercial world, it is a matter of common knowledge that wheat purchased immediately after harvest will gain in weight until and during the Winter. It was believed that the increase in weight was due to the absorption by the grain, of moisture from the atmosphere, but nothing definite was known regarding the amount of gain to be expected or when such occurred. With the object of gaining some information regarding these points, some experiments were conducted with small parcels of grain, the objects of the experiment being—

1. To ascertain the variations which take place in the moisture content of a parcel of wheat during a calendar year.

2. To ascertain whether constant and definite variations in their moisture content exist between varieties of different types, also between the same varieties when grown under different climatic conditions.

3. To ascertain whether there is any correlation between the moisture content of the wheat, and the relative humidity of the air.

The experiments were commenced during January, 1919, when samples of three varieties of wheat were obtained shortly after being harvested, from the School of Agriculture at Narrogin and the Experiment Farms at Merredin and Chapman. These localities are representative of widely separate districts within the wheat belt. The Chapman Farm is situated near its northern limit, it is about 35 miles north of Lat. 29° South and about 15 miles in an easterly direction from the sea (about 25 miles north from Geraldton and 260 miles from Perth). It has an elevation of about 500 feet above sea level. The Merredin Farm is on the eastern fringe of the Wheat Belt. It is situated 35 miles north of Lat 32° south and is about 160 miles from the sea in an easterly direction from Perth. It has an elevation of about 1,000 feet. The Narrogin School of Agriculture is on the western fringe. It is about 100 miles south-east from Perth and is situated about 65 miles south of Lat. 32° south and 90 miles east from the sea. It has an elevation of 1,200 feet above sea level.

During the harvest months the mean average shade temperatures recorded respectively at the three farms were as follows :—

	Chapman.	Merredin.	Narrogin.
	Degrees Fahrenheit.		
Mean Maximum Temperature (shade)—			
November	83·6	84·4	78·7
December	89·0	89·8	84·3
January	92·7	92·9	87·1
Mean Minimum Temperature (shade)—			
November	56·2	52·8	50·5
December	59·7	56·7	53·6
January	63·2	60·7	56·6

The varieties of wheat chosen were "Federation" representing the soft white type of wheat; "Bunyip" the straight grade or harder type, and "Comeback" the Australian strong hard white type. About 15lb. of the grain of each variety of wheat were obtained during January, and shortly after being harvested. Each parcel as taken was placed in a jute grain sack in which it remained during the course of the experiment and from which the samples required for the moisture determinations have been obtained.

So as to ascertain the moisture content of the wheat as freshly harvested, about 200 grammes were placed direct from the harvester into a lever top tin and sealed. The moisture content of these samples was determined on 21st January, 1919. It was intended to have had samples taken and moisture determinations made at monthly intervals from that date, but difficulty was experienced in obtaining suitable storage in close proximity to instruments by which the relative humidity of the air surrounding the wheat could be taken. Eventually arrangements were made to store the wheat in a small open-fronted galvanised iron shed (the sides and roof being iron) at my residence adjacent to the Swan River, Mt. Lawley, near Perth, and through the courtesy of Mr. Curlewis, Commonwealth Meteorological Officer, wet and dry bulb thermometers were installed adjacent to the stored wheat. The thermometers were set up on 15th June, 1919.

The second samples for moisture determination were taken a week later on 24th June, 1919, and afterwards at monthly periods. The samples on being taken were immediately placed in lever top tins, sealed for transport to the laboratory, where the moisture determinations were made by the co-operation of the Government Analyst and Agricultural Chemist (Mr. E. A. Mann), who has informed me that "the moisture determinations appearing in this paper have all been made in an air oven on whole grain subjected to a temperature of 130° C. for eight hours."

The following table has been prepared from his reports :—

TABLE I.

Monthly Variations in the Porcentage of Moisture Content of Wheat.

Date of Determination.	From Chapman.				From Merredin.				From Narrogin.				General Average.			
	Bunyip	Come-back.	Federation.	Average.	Bunyip.	Come-back.	Federation.	Average.	Bunyip.	Come-back.	Federation.	Average.	Bunyip.	Come-back.	Federation.	Average.
Sealed Sample from Farm—21st January, 1919	9·2	9·7	10·6	9·83	8·92	8·82	7·95	8·56	9·0	11·2	8·6	9·60	9·04	9·91	9·05	9·33
Monthly Analysis—June 24, 1919 ...	12·35	12·52	13·52	12·80	10·85	12·15	11·80	11·60	11·55	12·35	12·22	12·04	11·58	12·34	32·51	12·14
July 28, 1919	14·80	14·08	15·13	14·67	14·44	15·21	13·77	14·47	12·98	13·82	14·37	13·72	14·07	14·37	14·42	14·29
August 24, 1919 ...	15·13	14·95	15·39	15·16	15·06	14·22	14·74	14·67	14·41	14·97	14·40	14·59	14·87	14·71	14·84	14·81
September 24, 1919 ...	14·30	14·76	14·66	14·57	15·78	15·38	15·48	15·71	14·60	15·02	16·38	15·33	14·89	15·22	15·51	15·21
October 25, 1919 ...	13·04	13·99	13·30	13·44	13·80	13·73	12·48	13·34	12·43	13·35	13·74	13·17	13·09	13·69	13·17	13·32
November 25, 1919 ...	13·10	13·34	12·54	12·99	14·41	13·90	13·97	14·09	14·22	13·19	12·74	13·38	13·91	13·48	13·08	13·49
December 25, 1919 ...	14·49	13·45	14·17	14·04	14·33	12·89	13·34	13·52	13·06	13·65	12·79	13·17	13·96	13·33	13·43	13·57
January 25, 1920 ...	12·00	11·46	12·36	11·94	11·49	11·27	11·27	11·34	10·29	10·07	10·14	10·17	11·26	10·93	11·26	11·15
*February 25, 1920 ...	13·39	12·78	13·76	13·31	13·43	14·02	14·03	13·83	12·18	12·61	12·62	12·47	13·00	13·14	13·47	13·20
*March 21, 1920 ...	12·48	13·28	13·15	12·97	13·43	12·37	13·30	13·03	12·25	11·62	11·61	11·83	12·72	12·42	12·69	12·61
*April 25, 1920 ...	11·69	11·54	14·43	12·55	11·56	14·61	12·47	12·88	12·38	14·43	13·31	13·37	11·88	13·53	13·40	12·94
*May 25, 1920 ...	14·52	15·65	14·51	14·89	15·46	15·62	14·01	15·03	14·35	14·67	16·02	15·01	13·78	15·31	14·85	14·65
*June 25, 1920 ...	16·13	16·03	16·13	16·11	16·30	16·42	16·76	16·49	15·15	15·40	15·97	15·51	15·86	15·95	16·30	16·04

*Recorded subsequent to the reading of the Paper.

THE VARIATIONS IN THE MOISTURE CONTENT THROUGHOUT THE YEAR.

It is at once seen from Table I. that the wheat as harvested on the farm contains a very small amount of moisture, the mean for all varieties and all farms being 9·33 per cent. This is not quite as dry as freshly harvested Indian (Punjab) wheat which contains about 8·8* per cent. moisture, but is considerably below the standard prescribed for the highest grade of American wheat, viz., 13·50 per cent. As was to be expected the wheat from the interior farm at Merredin contained the least moisture and that from the northern farm, which is the nearest to the sea, slightly the most. By June the mean moisture content had increased to 12·14 per cent., a gain of 2·81 per cent. Then followed a monthly gain until September when the total mean gain amounted to the large amount of 5·88 per cent. with a moisture content of 15·21 per cent.

Following upon the maximum increase in weight there is then a gradual monthly decline until at the end of twelve months in January the mean moisture content has fallen to 11·15 per cent. or 1·82 per cent. in excess of the moisture content of the same wheat as found on the farms. It is concluded from this that, consequent upon the protection from the direct drying action of the sun's rays afforded by the sack with which the wheat is covered that the moisture content of stored wheat will not fall again to the same low level of the wheat as found in the harvest field.

These results are at entire variance with those obtained by Barnes and Grove at Lyallpur. In order to compare the amount of moisture contained in wheat during the moist months of July and August when the monsoon is in progress, with that in freshly harvested wheat in May, these investigators purchased samples of both hard and soft wheat from week to week during the months of July, August, September, and October in the Lyallpur bazaar market. The moisture in wheat freshly harvested in May was found to be—Hard Wheat, 8·7 per cent., Soft Wheat 8·8 per cent. The moisture content found in the purchased samples fluctuated irregularly throughout the period. In the case of soft bazaar wheat, the range was from 7·86 per cent. to 11·05 per cent. In the case of the hard wheat the range was from 8·17 per cent. to 10·62 per cent.

The writers state that the results obtained show the moisture content of the wheat has not advanced to any considerable extent over that of the recently harvested grain in May, and finally it is stated, "We conclude therefore that ordinarily speaking wheat is not a hygroscopic susbtance and cannot take up much more moisture than it contains at harvest time, the time when wheat is at its

*Barnes & Grove. The insects attacking stored wheat in the Punjab.

driest, and that moisture in the wheat is not the important factor in insect attack. Our results for the moisture content of wheat do not agree with those quoted by Fletcher."

It is not stated how the parcels from which the samples were taken had been stored or whether all had been stored in the same way. The lack of this information together with the obvious fact that the samples were not all from the same bulk, makes it very difficult for others than the investigators to draw any conclusions. It is believed, however, that though the differences found by them may not be sufficient to be the important factor in insect attack, yet the differences of 3·19 per cent. in the case of soft wheat and of 2·45 per cent. for hard wheat between the minimum and maximum moisture content, are sufficient to indicate that Indian wheat is hygroscopic and will absorb moisture from the atmosphere, as was found to be the case in the experiments now being discussed.

THE VARIATIONS IN THE MOISTURE CONTENT OF THE DIFFERENT VARIETIES.

From an examination of the results recorded in Table I, it is very evident that the variations between the moisture content of the different varieties are not at all constant. For instance, at the Chapman Farm "Bunyip" was found to contain the least moisture in January, June, September, and October; "Comeback" in July, August, December, and January, and "Federation" in November. Similar instances will be found in connection with the varieties from the other farms.

Nor is there any agreement between the moisture content of the same variety from the different places. This is shown by the following instances:—When harvested the varieties containing the least moisture were at Chapman "Bunyip," at Merredin and Narrogin "Federation." In June when the next determinations were made, the variety containing the least moisture was "Bunyip" at all farms. In July the variety was "Bunyip" at Chapman and Narrogin and "Federation" at Merredin. In August it was "Comeback" at Chapman and Merredin, and "Federation" at Narrogin. It is probable that the experiment was not delicate enough to bring out these points and for this purpose laboratory tests are probably necessary. Attempts were made to arrange laboratory tests which would provide information on this and other related matters but unfortunately these attempts were unsuccessful.

RELATION OF MOISTURE CONTENT TO RELATIVE HUMIDITY.

Following the installation of the wet and dry bulb thermometers, daily readings at 9 a.m. and 3 p.m. have been taken in

accordance with the usual custom, and from these the relative humidity has been calculated. The details of this are given in Table II. hereunder in which the mean humidity for one, two, three, and four weekly periods preceding the date on which the samples for moisture determinations were obtained.

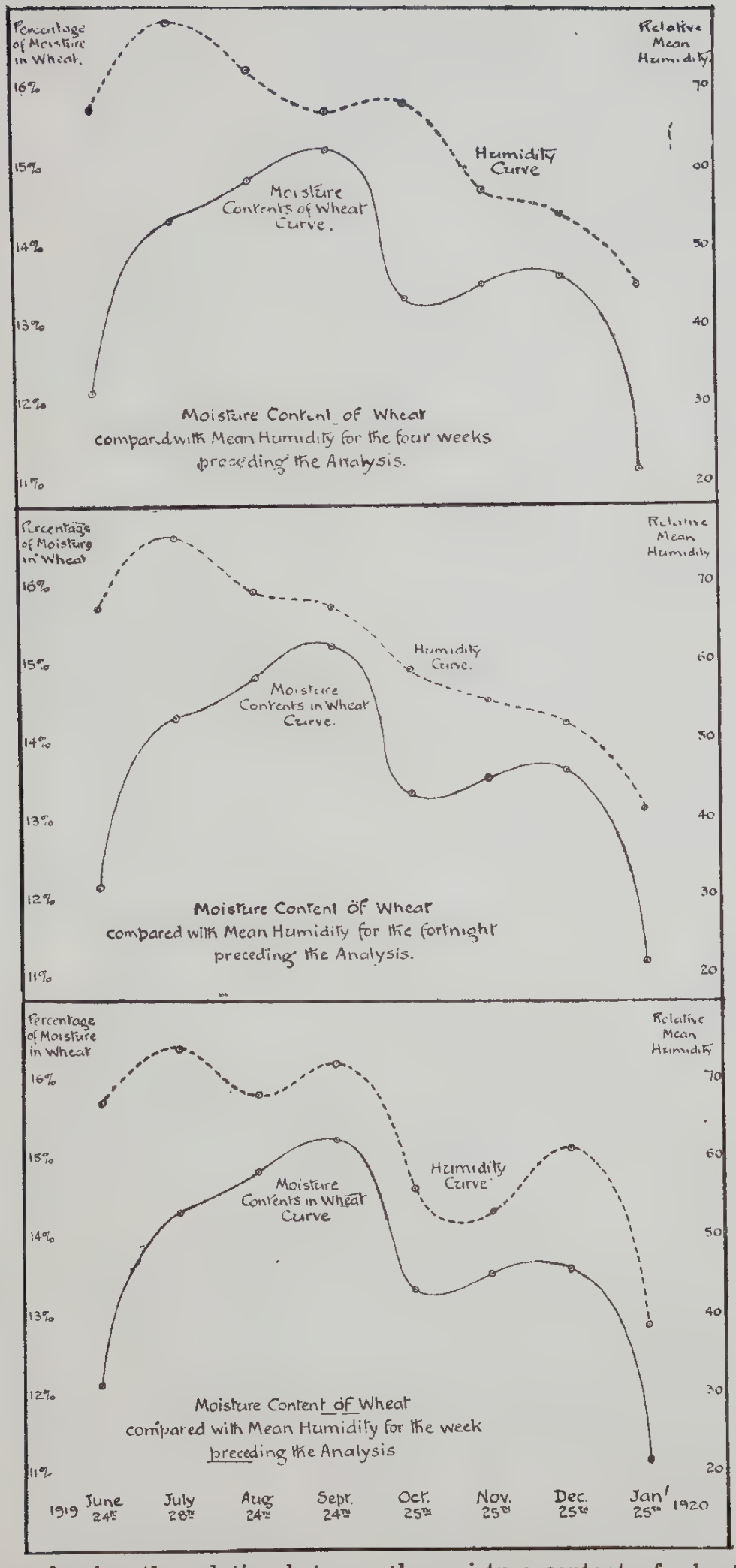
TABLE II.

Mean Humidity for the periods indicated to which Samples of Wheat were subjected prior to Samples being Tested for Moisture Content.

Sample taken on	Period.			Dry Bulb.			Wet Bulb.			Mean Humidity for Period.
	From.	To.	Days.	a.m.	p.m.	Mean.	a.m.	p.m.	Mean.	
1919.										
June 24	June 18	June 24	7	54·2	66·0	60·1	51·1	57·9	54·5	67
	July 1	July 28	28	56·7	65·9	61·3	54·8	60·2	57·5	78
	July 8	July 28	21	56·4	65·2	60·8	54·4	59·2	56·8	76
	July 15	July 28	14	57·7	65·9	61·8	55·3	59·8	57·6	76
July 28	July 22	July 28	7	57·7	64·2	61·0	54·9	58·0	56·5	74
	July 29	Aug. 24	27	54·8	64·7	59·8	51·7	58·0	54·9	72
	Aug. 4	Aug. 24	21	55·8	65·3	60·6	52·6	58·7	55·7	71
	Aug. 11	Aug. 24	14	55·2	66·2	60·7	51·8	58·7	55·3	69
Aug. 24	Aug. 18	Aug. 24	7	57·6	68·3	63·0	53·4	60·9	57·2	68
	Aug. 28	Sept. 24	28	58·9	65·4	62·4	54·7	58·4	56·6	67
	Sept. 4	Sept. 24	21	60·3	66·9	63·6	55·4	59·1	57·3	66
	Sept. 11	Sept. 24	14	61·4	66·7	64·1	56·1	59·8	58·0	67
Sept. 24	Sept. 18	Sept. 24	7	63·1	66·0	64·6	58·7	59·8	59·3	72
	Sept. 28	Oct. 25	28	62·7	66·0	64·4	56·9	60·3	58·6	68
	Oct. 5	Oct. 25	21	62·8	68·6	65·7	56·8	60·2	58·5	62
	Oct. 12	Oct. 25	14	63·8	70·5	67·2	57·2	61·2	59·2	59
Oct. 25	Oct 19.	Oct. 25	7	64·6	71·9	68·3	56·8	62·3	59·6	56
	Oct. 29	Nov. 25	28	69·6	74·8	72·2	61·5	64·2	62·9	57
	Nov. 5	Nov. 25	21	71·4	77·9	74·7	62·7	66·1	84·4	54
	Nov. 12	Nov. 25	14	72·5	78·5	75·0	63·0	66·3	64·7	55
Nov. 25	Nov. 19	Nov. 25	7	74·1	79·9	77·0	64·5	67·7	66·1	53
	Nov. 28	Dec. 25	28	76·6	78·9	77·8	66·2	67·6	66·9	54
	Dec. 5	Dec. 25	21	77·3	79·6	78·5	66·6	68·3	67·5	54
	Dec. 12	Dec. 25	14	77·6	79·5	78·6	66·2	67·6	66·9	52
Dec. 25	Dec. 19	Dec. 25	7	74·9	77·7	76·3	64·3	65·7	65·0	61
	Dec. 29	Jan. 25	28	83·1	91·5	87·3	70·2	74·0	72·1	45
1920.	Jan. 5	Jan. 25	21	83·5	92·7	88·1	69·6	74·1	71·9	43
	Jan. 12	Jan. 25	14	84·7	94·1	89·4	69·6	74·5	72·1	41
Jan. 25	Jan. 19	Jan. 25	7	88·1	98·7	93·4	71·4	76·8	74·1	38

From this data it will be seen that for the period under review the maximum humidity occurs early in July, and from that date there has been an almost consistent decline in the relative humidity until 25th January, with a specially rapid decline during the last month, when for the last period it was 38 per cent. or "dry." In order to ascertain if any relation existed between the relative humidity and the moisture content of the grain, curves have been plotted showing the variations which have occurred. In the case of the relative humidity, these are for periods of one, two, and four weeks preceding the moisture determinations. These are as follow :—

Fig. 11.



Curves showing the relation between the moisture content of wheat and the relative humidity of the air, June, 1919—January, 1920.

Another curve for a period of three days preceding the determinations was plotted, but it proved to be out of sympathy with them.

It will be seen that the relative humidity curve for the period of a week preceding the moisture determinations is most in sympathy with them. There are two instances of unsympathetic divergence. The first is in August when the moisture content curve fails to drop relatively with the fall in the humidity. This seems to be explained by the hypothesis that the wheat absorbed a considerable quantity of moisture, 2·15 per cent. between June and July and was unable in the period to absorb the full ratio consistent with the mean degree of humidity recorded or even consistent with the lower degree of humidity recorded for the next weekly period shown on the graph. The second divergence is in October when the moisture content fell lower than the mean humidity would seem to warrant. Some light is thrown on this by an examination of the relative humidity for each day in the weekly period. It is then found that on the fourth day preceding the taking of the samples for moisture determination the mean humidity was 42 per cent. This is an extreme and is 14 per cent. lower than the mean for the period.

This latter divergence from the sympathetic course of the curve is probably due to the rapid response to the drying character of the day referred to from which effect the wheat had not recovered when the samples were taken four days later.

A study of the results indicates that the wheat loses moisture more rapidly than it gains it. Seeing that the factors which influence the sympathy between the curves are not constant and if antagonistic factors do not exert equal influences in opposite directions, the sympathy between the curves must be regarded as good and from this it may be assumed that the moisture content of stored wheat is correlated with the mean relative humidity of the air.

Several writers have stated that small laboratory samples of wheat respond very rapidly to the fluctuations in relative humidity of the air and, Dondlinger in the "Book of Wheat," states than an increase of nine per cent. in twenty-four hours has been observed. This is probably an extreme instance. With the small parcels under trial the fluctuations were not nearly as rapid and were apparently correlated with the mean relative humidity of the previous week. It appears therefore as if the rapidity with which the changes in the moisture content of a parcel of wheat take place, has an inverse relation to its volume, due probably to the greater difficulty for air movement in large masses. In the case of large commercial parcels stored under the usual stack conditions, it may be assumed that the moisture content of the contents of the stack will be correlated with the relative humidity of a longer period than the week as in the case of the small experimental plots, and is probably a month.

The shape of the curve based upon the experimental results from June to September indicates that the gains during this period are cumulative and that in consequence large parcels of stored wheat will continue to gain moisture until the maximum is reached about October. In this State this maximum may be expected to be between five and six per cent. The curve from September to January indicates a slow decline until December with a rapid one in January, 1920. This month was remarkable for high temperatures and low humidity. During the weekly period prior to the samples being taken, the afternoon temperature ranged from 97·2 to 102 F. with five days over 101. This is unusual. From this it may be reasonably assumed that there will be a gradual decline in the moisture content of stored wheat, until in the middle of Summer it is between eleven and twelve per cent.

The fact that the moisture content of wheat and consequent increase or reduction in weight is correlated with the relative humidity, has an important commercial aspect, seeing that the bulk of the wheat grown in Australia in a normal season is shipped to Great Britain. The mean average humidity of London has been kindly supplied by the State Meteorologist (Mr. E. B. Curlewis), and is as follows :—

January	87	per cent.
February	85	,,
March	80	,,
April	75	,,
May	69	,,
June	69	,,
July	68	,,
August	74	,,
September	78	,,
October	80	,,
November	88	,,
December	87	,,

From this it will be seen that the minimum humidity for London is almost equal to our maximum and that in consequence any wheat shipped from this State can be expected to increase by some five per cent. above the weight as found in the harvest field. This increase in weight will compensate for losses which occur in transit and should assist in reducing the costs connected therewith.

Summarised, the results of this experiment show :—

1. That West Australian wheat as harvested is " very dry," though not as dry as Indian (Punjab) wheat but contains about four per cent. less moisture than the standard 13·50 per cent. prescribed for the highest grade American wheat.

2. That wheat as harvested regularly absorbs moisture and increases in weight until about October when the increase may be expected to amount to between five and six per cent.

3. It then loses moisture until January but does not become as dry as when harvested, the percentage increase above that period being about two per cent.

4. That if constant and definite variations in their moisture content exist between varieties of different types or between the same varieties from different districts, these experiments were not sufficiently delicate to demonstrate them.

5. That there is a correlation between the moisture content of wheat after harvest and the relative humidity of the air. In the case of the small experimental lots it is apparently correlated with the mean of a week. In the case of large parcels it is probably correlated with the mean of about a month.

APPENDIX.

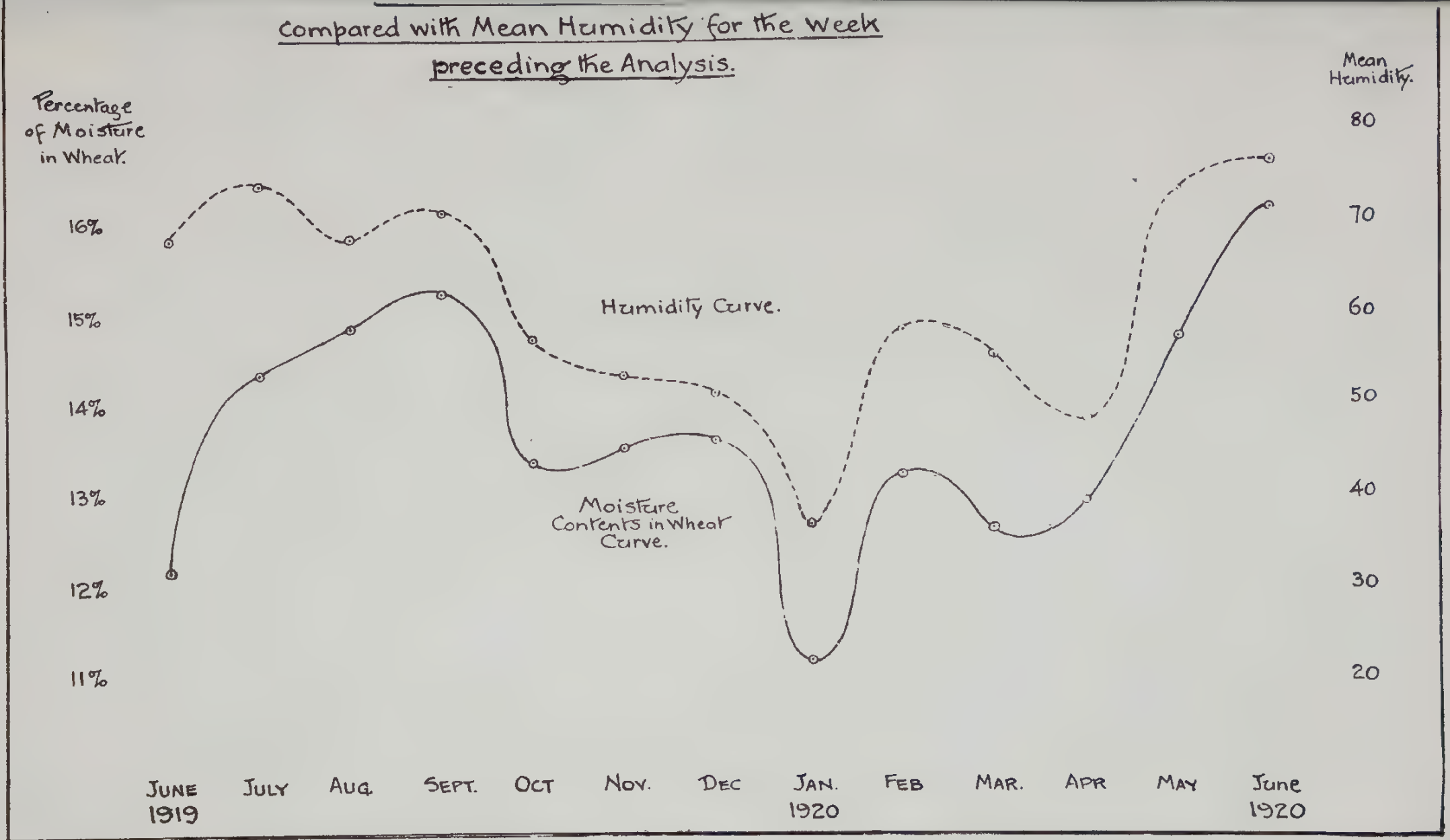
At the conclusion of the yearly period which followed the collection of the samples of wheat it was decided to continue the experiment until the following year so as to have a full period of a year during which to observe the relation of the humidity and moisture content curves to each other. The results of the moisture determinations for February to June, 1920, inclusive, have been included in Table I. and the temperatures and relative humidity for the weekly periods preceding the taking of the samples for the moisture for the full period are shown hereunder in Table III.

TABLE III.

Temperature Readings and Mean Humidity for a period of seven days preceding the Moisture Determination.

Sample of Wheat taken on.	Period.		Dry Bulb.			Wet Bulb.			Mean Humidity for Peri'd
	From.	To.	a.m.	p.m.	Mean.	a.m.	p.m.	Mean.	
June 24, 1919	June 18	June 24	54·2	66·0	60·1	51·1	57·9	54·5	68
July 28, 1919	July 22	July 28	57·7	64·2	61·0	54·9	58·0	56·5	74
Aug. 24, 1919	Aug. 18	Aug. 24	57·6	68·3	63·0	53·4	60·9	57·2	68
Sept. 24, 1919	Sept. 18	Sept. 24	63·1	66·0	64·6	58·7	59·8	59·3	71
Oct. 25, 1919	Oct. 19	Oct. 25	64·6	71·9	68·3	56·8	62·3	59·6	57
Nov. 25, 1919	Nov. 19	Nov. 25	74·1	79·9	77·0	64·5	67·7	66·1	53
Dec. 25, 1919	Dec. 19	Dec. 25	74·9	77·7	76·3	64·3	65·7	65·0	51
1920.									
Jan. 25, 1920	Jan. 19	Jan. 25	88·1	98·7	93·4	71·4	76·8	74·1	37
Feb. 25, 1920	Feb. 19	Feb. 25	75·3	82·6	79·0	67·2	71·2	69·2	59
March 26,1920	Mar. 20	Mar. 26	75·7	87·0	81·3	68·3	72·4	70·3	55
April 25, 1920	April 19	April 25	70·0	84·9	77·5	60·0	70·3	65·2	48
May 25, 1920	May 19	May 25	58·9	68·9	63·9	55·9	62·0	58·9	73
June 25, 1920	June 19	June 25	56·1	63·3	59·7	53·3	58·2	55·7	76

From the details in Tables I. and III., the curves in Fig. XII. have been prepared. From these it will be seen that the comparative sympathy found between the two curves in the first period, June, 1919, to January, 1920, is continued during the second period, January to June, 1920, thus confirming the conclusions already advanced.



Curves showing the relation between the moisture content of wheat and the relative humidity of the air, June, 1919—June, 1920.

Through the courtesy of the General Manager of the W.A. Wheat Marketing Scheme (Mr. F. C. Keys) I have had placed at my disposal the records of monthly weighings made with much larger parcels of wheat stored at the Wheat Storage Depôts, located at Midland Junction, Spencer's Brook and Dowerin. These weighings were made in order to ascertain the difference in weight which occurred in sacked wheat stored in the usual commercial way in sheds roofed with galvanised iron and protected on the sides with jute curtains. This commercial trial commenced in January, 1919, with wheat freshly harvested. The quantities under trial were at Midland Junction and Spencer's Brook 10 bags, and at Dowerin 30 bags. The Depôt at Midland Junction is in the Metropolitan area, 10 miles east of Perth with an elevation of 46 feet. Spencer's Brook is on the western fringe of the wheat belt and is about 50 miles in an easterly direction from Perth, with an elevation of 520 feet. Dowerin is situated in the wheat belt about 100 miles north-east from Perth with an elevation of 896 feet. The results of the weighings are in Table IV. hereunder :—

TABLE IV.

Results of Monthly Weighings of Sacks of Wheat at the depots named.

Month.	Dowerin (30 bags).	Midland Junction (10 bags).	Spencer's Brook (10 bags).
1919.	lbs.	lbs.	lbs.
January	5,526·50	1,797·50	1,934·50
February	5,526·75	1,820·00	1,955·50
March	5,546·50	1,828·00	1,956·50
April	5,606·00	1,838·00	1,966·75
May	5,626·75	1,847·50	1,985·75
June	5,674·00	1,855·00	2,008·75
July	5,713·00	1,865·50	2,021·25
August	5,744·00	1,872·25	2,038·50
September	5,743·75	1,872·25	2,043·00
October	5,718·50	1,880·50	2,049·00
November	5,696·75	1,879·50	2,035·50
December	5,660·50	1,873·75	2,029·75
1920.			
January	5,584·00	1,859·00	2,004·00
February	5,594·50	1,854·25	1,999·00
March	5,6[illegible]3·50	1,851·25	2,011·00
April	5,637·50	1,847·75	2,027·50
May	5,662·50	...	2,0[illegible]4·00
June	5,721·75	...	2,048·25

So as to have a common basis for comparison from the weights recorded, the percentage increases on the weights in January have

been calculated and together with the percentage increases of the small experimental lots are shown in Table V. hereunder :—

TABLE V.

Percentage of Moisture absorbed by Wheat in Bags at various depots.

(Based on January, 1919 0'.

—	Dowerin.	Midland Junction.	Spencer's Brook.	Perth Experimental Lots.
1919.				
January	·00	·00	·00	·00
February	·005	1·25	1·09	...
March	·362	1·70	1·14	...
April	1·44	2·25	1·67	...
May	1·81	2·18	2·65	...
June	2·67	3·20	3·84	2·81
July	3·37	3·78	4·48	4·96
August	3·94	4·16	5·38	5·48
September	3·93	4·16	5·61	5·88
October	3·47	4·62	5·92	3·99
November	3·08	4·56	5·22	4·16
December	2·42	4·24	4·92	4·24
1920.				
January	1·04	3·42	3·59	1·82
February	1·23	3·16	3·33	3·87
March	1·76	2·99	3·95	3·28
April	2·01	2·80	4·81	3·61
May	2·46	*	4·62	5·32
June	3·53	...	5·88	6·71

* Depot emptied prior to this date.

These trials show that wheat increases in weight during the wet winter months, and decreases during the dry months. In no case was the decrease sufficient to bring the weight back to that of the freshly harvested grain. As might be expected, the increase in the drier atmosphere of Dowerin was less than that at the more humid places. It is however, difficult to understand with the data available why the maximum percentage increase under the more humid conditions at Midland Junction was so much less than at the higher and drier locality at Spencer's Brook.

The maximum increase at Spencer's Brook, 5·92 per cent. approximates the maximum increase, 5·88 per cent., obtained a month earlier with the smaller quantities of wheat at Perth. The trials at the Storage Depots confirm the results obtained in the experiment with the smaller quantities of wheat and are specially interesting in that they have been obtained in a commercial way with bulk parcels.

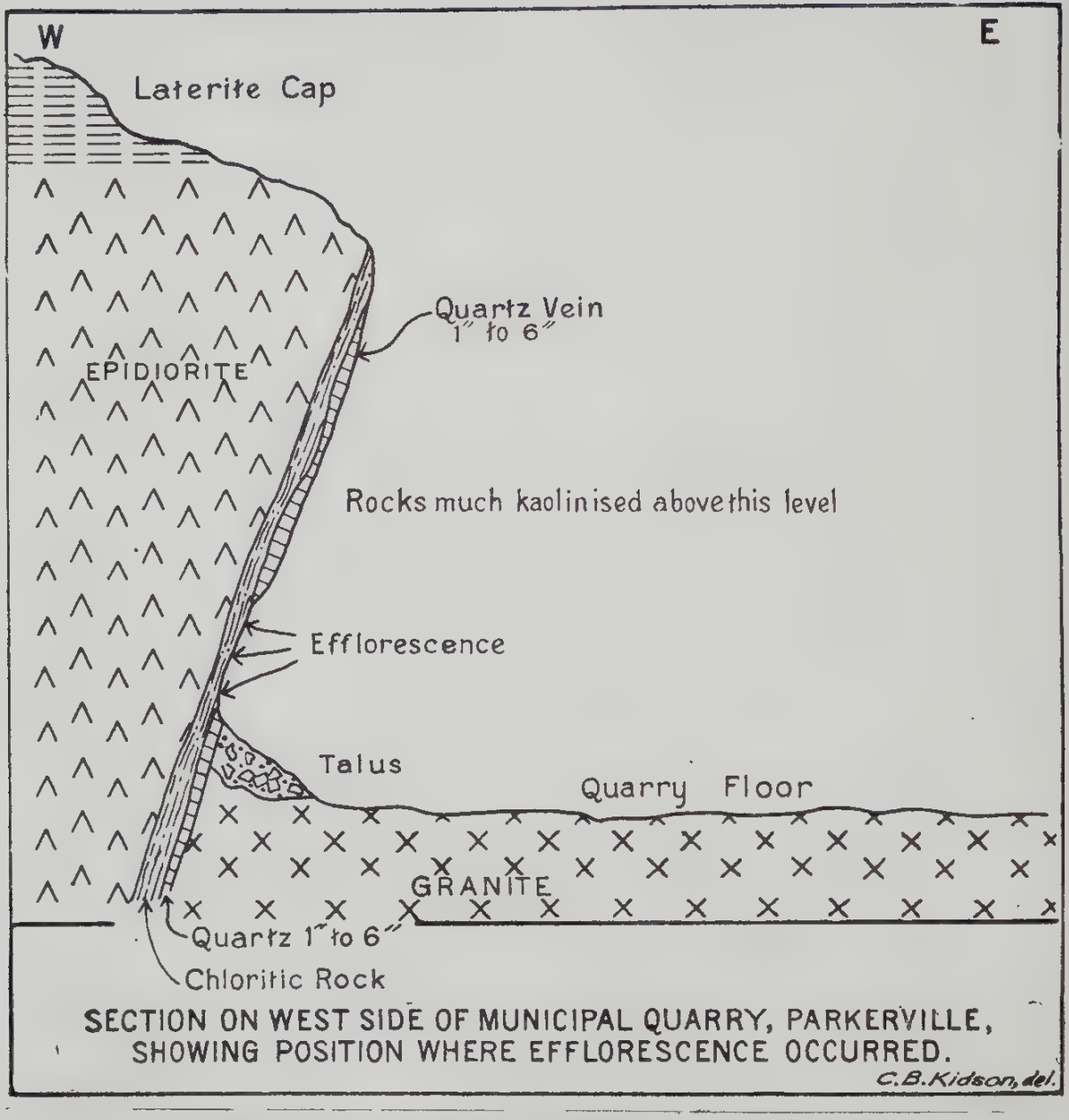
COBALTIFEROUS EPSOMITE AT PARKERVILLE.

By Edward S. Simpson, D.Sc., B.E., F.C.S., Government Mineralogist and Chemist.*

(*Read 13th April*, 1920.)

At the end of the summer of 1918–19 a white efflorescence was observed on a sheltered portion of the western wall of the Municipal Quarry at Parkerville. This township is situated in the midst of the immense granite massif of the Darling Ranges, the granite being traversed by a network of large epidiorite dykes and by pegmatite and quartz veins, with occasional narrow greenstone (camptonite or dolerite) dykes of much later date. The quarry has exposed large faces of epidiorite and granite, both completely kaolinised near the surface, but passing into solid rock at depths of 1·5 to 6·0 metres. The surface in the vicinity is covered with laterite.

Fig. 13.



*Published by permission of A. Gibb Maitland, Government Geologist.

The exact situation of the efflorescence relative to the rocks mentioned is indicated in the accompanying section (Fig. 13). It formed a soft loose white powder, three to twenty-five mm. thick, in discontinuous masses on the surface of a thin band of chlorite rock (altered camptonite or the crushed selvage of the epidiorite) lying between a large epidiorite dyke on the west side, and a narrow quartz vein, flanked by granite, on the east side. The efflorescence was distributed over a face about 15 metres long and o e metre high. It was found impossible to collect it entirely free from chloritic dust, but the material chosen for analysis, which was collected over about 0·2 square metres of rock, contained only ten per cent. of rock dust insoluble in water. The analysis of the water-soluble portion showed :—

	Epsomite, %	Parkerville. mols.		
MgO	16·59	4,116		
CoO	·70	93	4,272	
NiO	·39	52		4,515
CuO	·09	11		
CaO	1·36	243		
FeO, Fe_2O_3, Al_2O_3	*Nil*	...		
SO_3	36·05	4,503		
H_2O	[44·82]	24,872		
	100·00			

The figures may be restated thus :—

$MgSO_4 \cdot nH_2O$	91·78	
$CoSO_4 \cdot nH_2O$	2·41	Epsomite
$NiSO_4 \cdot nH_2O$	1·34	95·83
$CuSO_4 \cdot nH_2O$	0·30	
$CaSO_4 \cdot 2H_2O$	4·17	Gypsum.
	100·00	

In this statement n is 5·717 (*vide infra*).

The analysis indicates in the first place that the efflorescence is essentially epsomite, mixed with a small percentage of gypsum. The presence of appreciable amounts of cobalt, nickel, and copper sulphates co-crystallised with the magnesium sulphate appears to be almost unique, the only other occurrences found in the literature being that of Neusohl (Hungary)*, where the mineral was rose red

*Dana, 1889 Edit., p. 644.

in colour, and was found by Stromeyer to contain 0·38 of CuO and 0·69 of CoO, no information being given as to the quantity of NiO, if any, present. A nickel sulphate, morenosite, $NiSO_4 \cdot 7H_2O$, is known which is orthorhombic, and is isomorphous with epsomite, but the only known cobalt sulphate, bieberite, $CoSO_4 \cdot 7H_2O$, is monoclinic. The compound $MgSO_4 \cdot 7H_2O$ is, however, known to crystallise under artificial conditions in both orthorhombic and monoclinic forms, the latter isomorphous with bieberite. It is clear therefore that the three heptahydrated sulphates of magnesium, nickel, and cobalt are isodimorphous. The crystalline form of the Parkerville mineral was indeterminable.

The absence from the salt of all traces of iron and aluminium, both of which are far more abundant in the rock matrix than either cobalt or nickel, is at first sight remarkable, since the efflorescence can only originate in the oxidation of pyrite or pyrrhotite embedded in the igneous rocks which moreover contain a large proportion of alumina. A cobaltiferous pyrrhotite is the most probable source. There are, however, no large bodies of sulphides in the vicinity so that the solutions produced by the weathering pyrrhotite would be only weakly acid and would rapidly be neutralised by interaction with the abundant chlorite, giving a neutral solution of sulphates of magnesium, cobalt, nickel, ferrous iron, and probably aluminium. Whilst such solutions of magnesium, cobalt, and nickel are very stable, neutral sulphate solutions of iron and aluminium in the presence of oxygen rapidly precipitate simple basic salts or compound basic salts with alkalis (alunite, jarosite, etc.). Hence it arises that the final efflorescence contains neither iron nor aluminium.

The ratio of water and sulphuric oxide to protoxides in the Parkerville mineral, after allowing for the gypsum present, is :

(Mg, Co, Ni, Cu) O ...	1,001
SO_3	999
H_2O	5,717

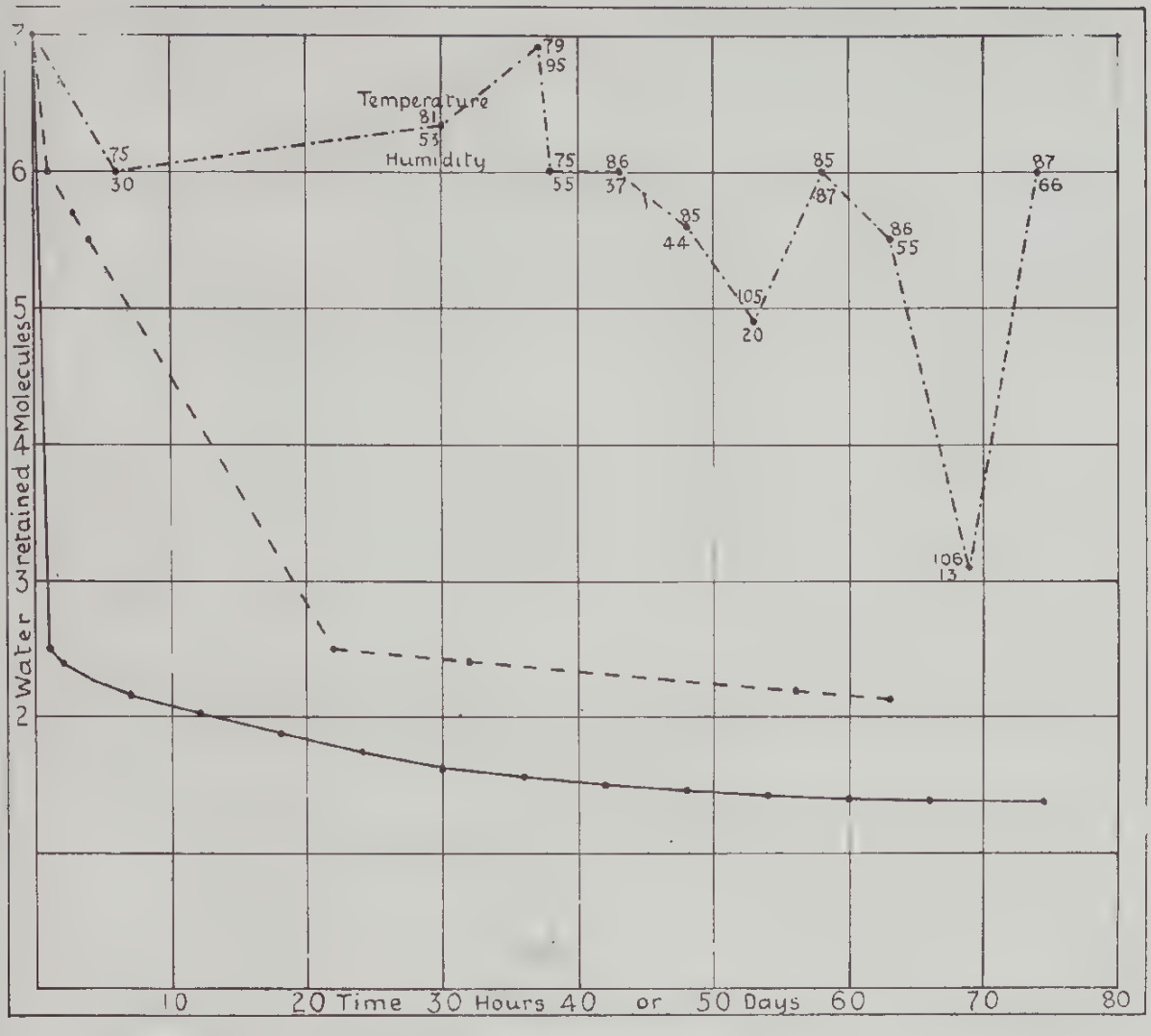
The SO_3 and protoxides balance well but the water is far below the normal ratio of 7 : 1. The artificial heptahydrate of magnesium sulphate (epsom salts) is known to be efflorescent and "loses its water by stages, and with decreasing aqueous tension."*

Experiments made in the author's laboratory to obtain more precise information on this point, yielded the curves shown in Fig. 14. These experiments showed (top curve) that under ordinary atmospheric conditions $MgSO_4 \cdot 7H_2O$ loses water of crystallisation temporarily in proportion to the rise of temperature and fall of humidity, the maximum loss recorded being almost four

*Alex. Smith : Introduction to Inorganic Chemistry p. 644.

molecules. With lower temperatures and increased humidity the salt reverts to its original condition of hydration.

Fig. 14.



Graph showing Dehydration of E somite.

Top curve, in air. Time units, days. Temperature, Fahrenheit degrees.

Middle curve, over sulphuric acid. Time units, days.

Bottom curve, in steam oven. Time units, hours.

Drying by heating at 100 degrees (bottom curve) or by keeping in a desiccator over strong sulphuric acid (middle curve) showed a rapid drop to $MgSO_4 2\frac{1}{2}H_2O$ and thereafter a very slow but regular loss of water with slowly decreasing tension.

It appears from these results that epsomite exposed to the atmosphere will vary in water content, possibly down to $MgSO_4 2\frac{1}{2}H_2O$, but will recover to its normal composition in cool damp weather. It is evident therefore that the abnormality in water content of the Parkerville mineral is due to a temporary partial dehydration brought about by the dry and hot atmosphere prevailing in the locality during the summer time, the efflorescence

being exposed during part of the morning to the direct rays of the sun. In view of the known tendency of artificial epsom salts to become partly dehydrated, it is surprising that no previous record has been made of natural dehydrated epsomite. This is partly perhaps because most epsomites which have been described have been taken from the walls or floors of mines or caverns, whose moist cool atmosphere would protect the salt from drying.

The Neusohl cobaltiferous epsomite is described as being of a rose red colour. The very finely divided Parkerville epsomite is pure white or greyish from admixed rock dust. A concentrated filtered solution of it possesses a strong smoky colour tinged with pink, the "smokiness" of which may be due to a minute amount of colloidal cobalt or nickel sulphide. On recrystallising the mineral in denser masses than the original, the salt still remains practically colourless, only a very faint pinkness being observed. It is evident that the colours proper to the sulphates of nickel and copper tend to mask that characteristic of the sulphate of cobalt.

The taste of the Parkerville mineral is strikingly different from normal epsomite, being acrid and astringent. These qualities must be ascribed to the sulphates of cobalt, nickel, and copper present.

Under the microscope the effiorescence appears as minute fllaments, curved and often branching. No straight crystals were observed by which the crystalline system might be determined, but the optical properties appear to be those normal to epsomite.

I am indebted to Mr. J. E. Wells, an enthusiastic local mineralogist, for drawing my attention to the efflorescence in the first instance.

Perth, 3rd February, 1920.

SOME HYMENOSOMIDAE FROM THE SWAN RIVER.

By Stephen K. Montgomery, B.A., B.Sc.

(*Read 13th April*, 1920.)

About October of 1919, Mr. W. B. Alexander, M.A., sent me some little crabs which had been caught in fishing nets in the Swan River, and had been sent to him by the Fisheries Department. These were found on examination to belong to the species *Hymenosoma australe* of Haswell, described by him as a new species in his "Catalogue of Australian Malacostraca, 1882." The only locality there given is Williamstown, Port Phillip.

Later, about March, 1920, further examples of the family Hymenosomidae were obtained, some from the boat sheds on the Swan River, other from dredge hauls in the Narrows.

Mr. Alexander had never met these crabs before, and none has been received hitherto by the Museum. This is, therefore, as far as can be ascertained from the available literature, the first record of the species from Western Australia. The only mention of the family which can be found from this State is in records of the "Challenger" Expedition, in E. J. Mier's report on the Decapoda Brachyura, he there mentions a small specimen from King George's Sound, as probably *Halicarcinus ovatus*.

The genus *Hymenosoma* is one about which there has been considerable difference of opinion. Not only is the whole family *Hymenosomidae* of uncertain affinities, but also there is difficulty in dividing up the various genera composing it. The view of Miers is that among other genera there are three closely related, namely *Hymenosoma* (Leach), *Halicarcinus* (White), and *Hymenicus* (Dana), separated from one another by small but definite points of difference. *Hymenosoma* and *Halicarcinus* are the only ones with which this note is concerned. Miers distinguishes the latter from the former by the following characters:—"The carapace is more transverse and rounded, less distinctly triangulate. The front is distinctly trilobated. The basal segment of the abdomen in the male occupies the whole width of the sternum, between the bases of the fifth ambulatory legs. The exterior maxillipedes (in the typical species at least) are more robust, and more strongly developed, with the palms more turgid, and the dactyli of the ambulatory legs are more distinctly falcated."—(Miers.)

Professor W. A. Haswell, however, says (loc. cit.):—"The subdivision of this family (*Hymenosomidae*) into the genera *Hymenosoma*, *Hymenicus*, and *Halicarcinus* appears to be unnecessary and based on extremely slight points of distinction, and I have therefore placed all the species under Leach's original genus." In accordance with this view, he therefore describes his

new genus as *Hymenosoma australe*. His description reads, "Carapace sub-orbiculate, the length (exclusive of the rostrum) a little less than the greatest breadth. Rostrum prominent, deflexed, its upper surface concave from side to side, bordered laterally by a raised ridge, which terminates near the extremity in a slight enlargement; extremity in the form of an obtuse angle. Lateral borders of the carapace with two obscure teeth. Chelipedes of the male extremely large, propodos dilated, smooth, rather sharp edged below, fingers gaping at the base, with a projecting pulvinus. Chelipedes of female small, hand not dilated, fingers straight; length half an inch."

The specimens which Mr. Alexander sent were five males, and coincided well with the description and figure of Haswell. The pulvinus on the cheliped of the majority of these specimens was far better developed than is shown in his figure.

It will be noted, however, that if Mier's view of the three distinct genera is taken, several points in Haswell's description point to *Halicarcinus* rather than *Hymenosoma*. For example, the shape of the carapace is sub-orbiculate not triangulate; and in the specimens under discussion this also holds. Again, the typical *Hymenosoma* has the front "simple, triangulate, and nearly horizontal"; the specimens, though Haswell's description fits them, have also, as in *Halicarcinus*, the front "distinctly trilobated." Haswell's description and the specimens also point to *Halicarcinus* rather than *Hymenosoma* with regard to the shape and size of the chelipedes. In other points also they come under the genus *Halicarcinus*; there is a distinct epistome which is transverse, the exterior maxillipedes are stout and the dactyli of the ambulatory legs are not straight, though the curvature is certainly slight.

If Mier's view is accepted, therefore, we are compelled to regard these specimens as *Halicarcinus* rather than *Hymenosoma*. In this case, Haswell's specific name must be kept, and the species referred to as *Halicarcinus* (White), *australe* (Haswell).

Of the other specimens, those from the boat sheds are one female and one male, and are in all respects similar to those sent by Mr. Alexander, except that the chelipedes of the male specimen are very small and like those of the female, though the typical pulvinus is present.

The specimens from the Narrows are quite different. They are smaller, being not more than 0·2 inch long, and the grooving of the carapace, which is most marked in the other specimens is hardly present at all. The carapace is triangulate, the front simple, triangulate, and horizontal, and the exterior maxillipedes are slender; all three characters place the specimen, according to Miers, under the genus *Hymenosoma*. On the other hand, the epistome, though indistinct, is certainly present, and the dactyli of the ambulatory legs are quite strongly curved. The character

of the chelipedes and of the basal segment of the post-abdomen is of no value in the case of these specimens, as all are females.

At first, considering the differences in size and the fact that the two sets of specimens came from the same locality, it seemed probable that the latter specimens were merely young stages of the former, and that the differences were merely growth changes ; in other words, that Haswell's opinion was the correct one, that the two genera, *Hymenosoma* and *Halicarcinus*, were not to be distinguished. But all the small specimens, which were all females, were sexually mature and were carrying eggs ; and it is hard to believe that the crabs would grow nearly three times as large after reaching sexual maturity. The probability is, therefore, that in these smaller specimens we have another genus, *Hymenosoma*, if we follow Miers in making a distinction, or, at any rate, if we follow Haswell, another species, not *H. australe*. Miers mentions Haswell's combination of the genera in both his "Challenger" Brachyura Report, and his memoir on the Crustacea collected by H.M.S. "Alert," but without comment in each case. Access to any further literature on the subject has been impossible, and an opinion on the advisability of separating the genera would not be justified.

A further problem presents itself with regard to the affinities of the *Hymenosomidae* with other families. Generally they are considered as relations of those families formerly grouped as Catometopa (generally distinguished by a typically square carapace) and are placed most nearly with the Pinnoteridae or Pea crabs, the Mictyridae, and the Plagusiidae. Ortmann, according to Alcock (Materials for a Carcinological Fauna of India, No. 6, pp. 282 and 291), removes them entirely from the Catometopa, and allies them with the Oxyrhyncha, or Spider-crabs, which are, in general, provided with a triangular carapace and a sharp frontal spine or rostrum. The characters of the two tribes are stated as follows by Alcock (*Loc. cit.*) :—

Catometopa.—"The carapace is variable, but commonly and typically it is transverse, more or less quadrate, with large branchial and small and indistinct hepatic regions and a broad front. The front is also variable in form but typically is much deflexed.

The orbits, typically, occupy the whole or the greater part of the anterior border of the carapace on either side of the front. The typical fold of the antennules is transverse, but it may be oblique, or nearly vertical, and in a few cases there are no distinct fossae at all into which these appendages can fold.

The epistome, typically, is extremely short, but occasionally it is of considerable length. The buccal orifice is typically, but by no means always square cut. The palp of the external maxillipedes usually articulates either at the summit, or at or near the external angle of the merus.

The genital ducts of the male usually perforate the sternum, opposite the last pair of legs, ...

The abdomen of the male is very often narrow at its base and so does not cover all the space between the last pair of legs.

The branchiae are often fewer than nine, from eight to six on either side, their efferent channels open on either side of the palate."

Oxyrhyncha.—"Carapace more or less narrowed in front, and usually produced in the form of a rostrum, branchial regions considerably developed, hepatic regions small. Epistome usually large, buccal cavity quadrate, with the anterior margin straight. Branchiae almost always nine on either side ; their efferent channels open at the sides of the endostome or palate. Antennules longitudinally folded. The palp of the external maxillipedes is articulated either at the summit or the antero-internal angle of the meropodite. The external genitalia of the male are inserted at the bases of the fifth pair of trunk legs."

In the specimens here recorded, the shapes of the carapace and the front recall the Oxyrhyncha rather than the Catometopes, as do also the extent of the orbits and the fold of the antennules, which is longitudinal. The character of the epistome varies in the family but its absence in some is more like a Catometope character than an Oxyrhynch. The articulation of the palp of the external maxillipede is near the summit of the merus, but nearer the antero-internal angle than otherwise ; this favours the Oxyrhynch view. The external genitalia appear to perforate the sternum and not to arise at the base of the fifth pair of trunk legs ; this inclines towarded the Catometope. The branchiae are apparently seven, as in many Catometopes. It is seen, therefore, that the family cannot be put in either tribe with certainty. Miers and Alcock take them as Catometope, the latter considering Ortmann's view, "a decided mistake." Mr. L. A. Borradaile, of Cambridge, follows Ortmann, but his paper is not available ; Mr. T. Douglas Laurie, of Liverpool, refers to them on opposite pages of the same paper, once in conjunction with Catometope families, and again under the Oxyrhyncha ; and Miss M. J. Rathbun, of Washington, describes a *Halicarcinus* as an Oxyrhynch, in her report on the Crustacea taken by the Mawson South Polar Expeditition, but in her list of the Brachyura collected by Mr. Stanley J. Gardiner, in the "Sealark," she places them between the Catometope families and the Oxyrhyncha, making, apparently, a series of the Plagusiidae, *Hapalocarcinidae*, *Hymenosomidae*, and the Inachidae, the first group of the Oxyrhyncha.

This note has been put forward with two objects, one to place on record the occurrence of this family in the Swan River, and the other to indicate the nature of the problems in carcinology which await solution, and the impossibility of dealing with them effectively without good collections and the necessary literature.

NOTES ON WESTERN AUSTRALIAN ANT-NEST BEETLES.

By J. Clark.

(*Read* 11*th May*, 1920.)

With a view to encouraging Nature Study in general, and Entomology in particular, I would like to draw the attention of the members of our Society to a large field for observation that exists in this State.

Amongst the insects of Western Australia are many large, handsome, and remarkable species, which are much sought after by Naturalists, but none so remarkable, though small, than those which spend all or part of their lives in the nests of ants and white ants. The majority of insects found in ants' nests are beetles, but representatives of many other orders are found.

Mealy-bugs are plentiful, a few species of true bugs, at least two species of flies, and many lepidopterous larvae are to be taken in nests about Perth. Spiders, mites, wood-lice, and chelifers abound in most nests which have been long established.

It is unnecessary to go into detail of all the species of insects found in ants' nest, as a most interesting paper by Mr. A. M. Lea was published in the Victorian "Naturalist" (Volume XXVII., 3, 1910, pp. 50–56) dealing with this subject.

A great deal has been done in the Eastern States in connection with this branch of Entomology, but comparatively little has been done here, and no observations have been made on the life history of any of the species so found in this State, so that a great field awaits the Naturalist here for there is an abundance of material to work on, and the ease with which it can be obtained must appeal to many when they realise the interest of the work.

One of the nests about Perth which generally contains a number of guests, or inquilines, is that of the twig mound ant, *Iridomyrmex conifer*, Forel., and from it many remarkable insects have been taken.

The nest is productive at all times of the year, but gives the best results during May to October. This ant shows remarkable building ability and foresight ; the nests being built up of twigs, grass, leaves, etc., are very easily destroyed by bush fires which are general during the dry months of the year, and it is a very common sight to see many of these burned out nests during a walk in the bush. On the approach of summer the ants, apparently aware of the danger, forsake their mound nest, seek a clear open space and there excavate a nest underground. The summer and winter nests are so dissimilar as to appear to be the work of two different species of ants, one a builder, the other a miner.

The size and position of the nests of this ant vary considerably. In some localities it is difficult to find a nest more than nine inches

high, and about twelve inches wide at the bottom, while in other places they reach eighteen inches in height, and twenty to twenty-six inches in width at the bottom. Most of the large nests have been built up round a small plant or other support, while the smaller nests are usually in open country with no support. On several occasions nests have been observed under half buried logs and stumps, with little or no twig mound over them, the few twigs, etc., brought together only serving to cover the various entrances to the nest.

The site of the summer nest is usually in a position shaded from the heat of the sun ; it is a basin-shaped excavation, generally about six inches deep and fourteen to eighteen inches in diameter, divided into several chambers or compartments. These contain the different stages of larvae and pupae. The top chambers are usually about three inches below the surface of the ground. The material excavated is carried clear of the nest, and deposited round the outside, giving the nest a sunken appearance. Entrance is gained at several points, but the main one is usually about the centre.

The twig or mound nest is sometimes built up over the summer nest, but at other times a new nest is constructed, usually at the foot of a small plant, or in an old root underground. The average nest is about ten or twelve inches high, and about sixteen to eighteen inches in diameter, at the surface of the ground. Building is commenced by arranging long twigs and bits of grass, round and about the central entrance, many ants often working with one piece of twig until it is got into position. Each ant usually works alone with its twig until the nest is reached, when others assist to carry or drag the piece into position. Soil and other material excavated is laid on and covers the twigs for about one-third of the height of the mound, making the building more secure : entrance is gained at many points round and on the mound, but there always appears to be a main entrance, round which many ants gather as though keeping guard.

While many ants are excavating, others are carrying twigs, grass, leaves, etc., and others carrying and depositing their burden of larvae and pupae, the whole representing a very busy scene.

The arrangement of the larvae and pupae in this nest is very similar to the summer nest, but the chambers are larger and fewer. Two queens have at various times been taken in one nest. They are always at the bottom and do not appear to occupy any particular chamber. Several small chambers containing eggs are also at the bottom, but these are often to be seen in topchambers. They are small whitish objects, and usually in large numbers. The larvae are small and of a yellowish colour. They are found in various parts of the nest : the pupae are naked and usually occupy the centre chambers.

Large numbers of larvae and pupae of winged males and females are sometimes to be found in nests, the sexes being about equal in numbers. The large female is fully twice the size of the male and the workers, who are both of the same size (5 mm.). The antennae, however, are totally different ; in the female and the workers this is twelve jointed, the scape being equal in length to the following seven joints of the funiculis which has eleven joints subequal : the antennae of the male has thirteen joints, and the scape only the length of the following two joints, and the third only half the length of the fourth.

The colour varies slightly, but generally the head and thorax are of a dull brownish tinge, and the abdomen black ; many freshly emerged specimens can always be taken in the nests and these are of a light grey colour.

A most peculiar odour pervades the nests, and when disturbed, can be noticed for some distance. The smell does not arise from the material of which the nest is composed, as the summer nest which contains no vegetable matter gives off the same powerful odour.

During the removals from one nest to the other none of the intruding beetles and other insects have been seen amongst the quick-moving columns of ants, each with its burden of larva or pupa, but on digging out and examining many such nests, many of the guest insects have been obtained. In searching this nest for inquilines it has been found that very few species are to be obtained in the mound or twig portion, the only one so far recorded being the large *Cryptodes variolosus*, but on removing the top the whole nest is exposed showing large numbers of larvae and pupae. It is amongst these, and in this region that all or most of the guests will be found. It is here also where the observer has to be quick. These ants do not sting, but they bite (and are generally in a hurry to do it) and on the least alarm they swarm out in thousands, attacking everything in the way, so that examining this nest in the bush is a very difficult matter, the more so as most of the species are small and slow movers.

The following method was therefore adopted for dealing with them and answers well. On finding a well-built nest in which the ants are very active, a clear spot is selected alongside on which to stand. A large paper or calico bag is placed alongside : the bottom of the nest is first dug into with a small shovel, letting the top fall to the ground when lifting, quickly dropping the lot into the bag. The whole nest is taken and the bag securely fastened. While digging it is necessary to keep stamping the feet to keep the ants off.

On arrival home the nest is put in a kerosene tin, or other smooth container on which the ants will not climb, preparatory to sieving. Three sizes of seives are used, the largest one being quarter-inch mesh, which is used to remove the rubbish, leaves,

sticks, and stones. As a rule no beetles will be found in this material, except the large *Cryptodus*, which is about three-quarters of an inch long, so that it can easily be seen. Large numbers of this species can often be taken from a single nest. The next size sieve is one-eighth of an inch mesh (or the size of fly screen wire) : everything that does not pass through it is treated as large or No. 2. The last sieve is fine and is used to clear off the fine dust, which seldom contains anything except the smallest mites ; the material from this sieve is treated at No. 3, and the dust as No. 4. These are all sieved into separate tins and kept apart until examined. Two large-sized tubs are required for further examination. In one of these a kerosene tin is laid on its side, and a board with a a sheet of white paper placed on top, makes an excellent though small observation table. The large (No. 2) material is examined first, by taking a little on a trowel and sprinkling lightly over the paper. At first nothing will be seen but hurrying ants. These run to the edge of the paper and drop into the tub, and owing to the very smooth surface they cannot climb out. In a few moments many of the other insects start to move, and are soon detected and transferred to the tubes. In this material all the larger species will be found, such as *Enasiba* and *Chlamydopsis*, so that little time need be spent in examining it. As most, if not all of the ants will have disappeared from the paper, the contents are thrown into the clean tub kept ready for the purpose. This is continued until the whole of the material has been examined, and by throwing it into the spare tub, it can be looked over some hours afterwards, for it will be found that several specimens have remained so quiet as to escape detection, but on being left alone for a time, these burrow to the surface in their efforts to get away. Some fine and rare species may be taken in that way.

The medium material (No. 3) contains most of the species to be found in these nests. Some, such as *Articerus* and *Ectrephes*, move off at once on being placed on the paper, but others such as *Euclarkia* and *Thorictosoma*, will not move for some time, and must be searched for. The best way to pick them off the paper is to dip a small fine pointed brush in spirits, and touch the specimen lightly ; it will adhere and can then be transferred without injury which would otherwise result if lifted by forceps. Specimens of the ants should always be placed in the spirit tubes with the other insects, and when all such specimens are mounted on cards, a second card with specimens of the ants should be placed on the same pins, under the beetles. This not only adds interest to a collection, but is necessary to prevent confusion which would otherwise result.

In addition to the many species of insects which are known to be constant visitors to ants nests several species will be found at times, whose presence in nests would seem to be either accidental, or because they are victims of the ants. Several such have been

taken with this ant, but as nothing definite has been obtained about them, they are, for the present, excluded from the list. Large numbers of larvae of various insects are often met with during examination of material, but trouble is generally experienced in rearing these to maturity owing to the difficulty of ascertaining what they are living on. The full grown larva of a moth, and also some syrphid flies have been reared, but these have not been definitely identified yet.

At present several pupae of moths are under observation. They are the first of many to pupate. These will be dealt with in a later part of this series.

COLEOPTERA FROM NEST OF IRIDOMYRMEX CONIFERA (FOREL).

CARABIDAE.

Adelotopus occidentalis, Cast, Perth.

A small shiny black beetle, which at first glance looks more like one of the small Water-beetles than a Carab. It is an extremely quick moving species, and easily evades capture. This beetle is carnivorous and feeds on ants away from their nests. It can also be found under loose bark, stones, etc., where there are no ants.

STAPHYLINIDAE.

Several new and interesting species of this family have been taken, allied to the European genus *Dinarda*, about which so much has been written. They will be dealt with later.

PSELAPHIDAE.

Pselaphus tuberculifrons, Lea, Perth.
Eupines sulcata, Sharp, Perth.
Palimbolus dimidiatus, Raff, Perth.
Articerus foveicollis, Raff, Perth.
Articerus subcylindricornis, Lea, Perth.

The members of this family feed on the mites which are abundant in most nests. With the exception of the species of *Articerus*, most of the family occur rather sparingly. They are all small and of a reddish-brown colour. They move about amongst the ants in a most friendly manner. The species of the genus *Pselaphus* have the palpi almost or quite as long as the antennae, while those of the *Articerus* are remarkable for each antenna being apparently composed of one long joint, although there are really two, and for the apparent absence of palpi. *A. foveicollis* is abundant in most nests, while *A. subcylindricornis* is rare.

SCYDMAENIDAE.

Scydmaenus opatus, Sharp, Perth, Victoria Park.

This beetle occurs rather sparingly, and like the members of the preceding family, feeds on mites.

HISTERIDAE.

Chlamydopsis inquilina, Lewis, Perth, Canning River.

This species is most abundant in nests from the Canning River District, although it has been taken in many places about Perth. The type was taken by the late Mr. F. H. Du Boulay, thirty years ago, and was recorded as from New South Wales. It has been noted by Mr. A. M. Lea that this is probably an error, as Mr. Du Boulay did a lot of collecting from ants nests in Western Australia, and not in N.S. Wales. The fact that so many specimens have been obtained here supports his view, as apparently no specimens have been taken in N.S. Wales. The species of this genus are extremely rare, and are probably all hostile to the ants. They are remarkably sculptured beetles, and when at rest have the head withdrawn into the thorax, with the basil joint of the antennae fitted into grooves, and some of the legs also packed into grooves or otherwise protected.

COLYDIIDAE.

Euclarkia costata, Lea, Victoria Park, Jandakot.

A recently described and remarkable species which occurs in numbers in some nests. This beetle is easily overlooked, as it closely resembles the material of which the nest is composed, and it remains motionless for a long time. It can, however, move very quickly when it starts. It is remarkably close to a Victorian species of the family, *Kershawia rugiceps*, Lea, but has totally different antennae. At first sight the antennae seems one-jointed and look as if they were broken off. They are really three-jointed (in *Kershawia* they are nine-jointed). The species vary in colour from light brown to almost black, and have wings.

SCARABAEIDAE.

Cryptodus variolosus, White, Perth.

One of the largest beetles found in ants nests. It is three-fourths of an inch long. As the mouth parts of all the species are curiously modified they are probably all hostile to the ants. This species can be taken in numbers in most nests.

ELATERIDAE.

Cardiophorus sp., Perth, Maylands.

Several specimens of a small unidentified species of this genus have (so far only) been found in these nests. These will be dealt with later.

TENEBRIONIDAE.

Thorictosoma ectatommae, Lea, Perth, Canning River.

An interesting and recently described species, which has been taken in the nests of three species of ants, but never numerous This beetle has no sign of eyes and is wingless –it is a very slow mover and has to be well looked for.

A second species *T. tibiale*, Lea, was taken at Geraldton by Mr. A. M. Lea, who considers it probable that it is an ants nest species. It is closely allied to *T. ectatommae*.

Hyocis. sp., Mt. Lawley, Maylands.

Several specimens of a small species have been obtained. They are also to be taken in nests of *Cremastogaster*, but are not numerous. They will be dealt with later.

Ectyche erebea. Pasc., Perth.

This species occurs frequently in nests, but can also be taken in numbers under stones, logs, etc., where there are no ants. They have frequently been watched running about amongst the ants in a friendly manner.

PTINIDAE.

Diphobia longicornis, Lea, Victoria Park.

A recently described species of which very few specimens have been obtained. They are all from the same locality.

Diplocotes foveicollis, Oll. Perth, Serpentine River.

Several specimens have been taken in nests. This species was first described from New South Wales.

Ectrephes formicarum, Pasc., Perth, Jandakot.

This species is numerous in most nests, and is very variable in size. The peculiar antennae look different from different points of view. Four species of this remarkable genus are recorded from W. Australia.

Enasiba tristis, Oll., Perth.

This remarkable and rare beetle has been taken in a few places about Perth, but only in nests of this ant. The type and only specimen was taken at King George's Sound many years ago, and remained unique until quite recently. It is regarded as the finest of our Western Australian ants-nest beetles ; the peculiar antennae look very different when viewed from the top and from the side. The specimens vary much in size and colour, and as they are very slow movers, they easily escape detection. Most of the specimens have been taken in the tub after the material had been examined on the paper.

Hexaplocotes sulcifrons, Lea, Perth, Beverley.

Very few of this remarkable species have been taken at Perth, but Mr. Du Boulay took several specimens in nests at Beverley. Its antennae are remarkable, seen from the top, the two apical joints are greatly produced transversely, giving it a disc-like appearance, but when viewed from the side they appear normal.

CURCULIONIDAE.

Several species have been found, but most of them appear to be accidental or victims of the ants. One small species occurs, which, so far, has only been taken in nests ; it has large projecting eyes, and is rather an interesting weevil. This will shortly be described by Mr. A. M. Lea.

ANTHICIDAE.

Anthicus australis, King, Perth.

This species is occasional, and is found in the nests during wet weather, but is never numerous.

In addition to the beetles mentioned several others have been taken, but as they have not yet been identified, or are doubtfully connected with the ants, they will be dealt with in a later part of this series.

CONTRIBUTIONS TO THE FLORA OF WESTERN AUSTRALIA.

No. 1.

PROTEACEAE, RUTACEAE, POLYPORACEAE, PHALLOIDEAE.

By D. A. Herbert, M.Sc., Economic Botanist, Analytical Department, Perth.

Read 11th May, 1920.

Proteaceae.

Isopogon occidentalis, sp. nov.

A shrub, the branches slightly silky pubescent. Leaves once or twice divided into rigid terete segments about three-quarter to one line in diameter, obtuse or mucronate, erect or spreading, the whole leaf under three inches long generally two to two and a half inches. Cones terminal ovoid about eight lines broad and one inch long with flowers. Outer bracts few, two to five lines long pubescent outside, glabrous inside. Cone scales two and a half lines long, broadly cuneate, woolly outside, glabrous inside, narrower than in *I. divergens*. Perianth about seven lines long, glabrous except for terminal tufts of hairs on the ends of the segments. Style-end clavate, minutely but densely pubescent, separated from the bulbous base of the brush by a slight construction. Brush pappilose on the bulbous base, otherwise glabrous. Receptacle ovoid cylindrical.

Locality —Cranbrook (Dr. Stoward), East from Solomon's Well ; Stirling Range (Dr. A. Morrison).
Flowering period—September.

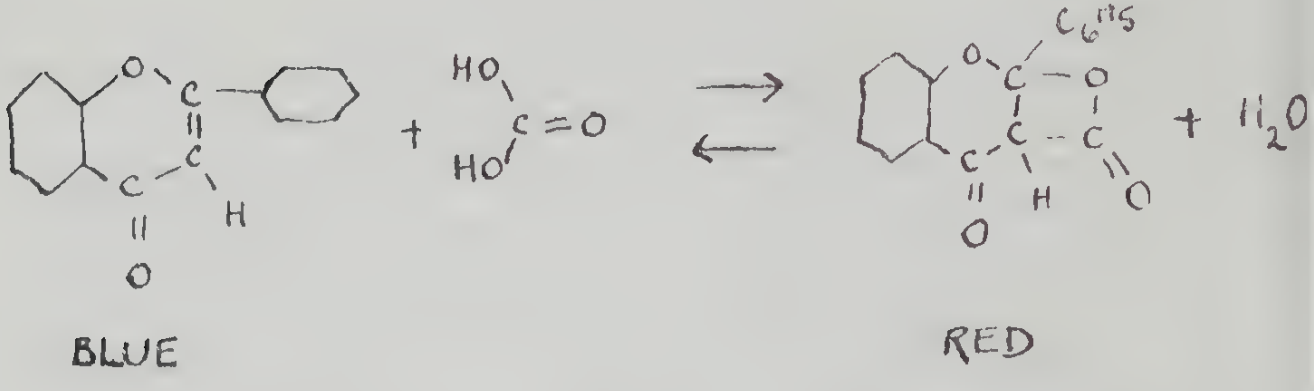
The new species has its nearest affinity in *I. divergens*, R. Br., from which it differs in its minutely silky pubescent branches, the length of the leaves, size of cones, shape of cone-scales, length of perianth, and the brush.

Rutaceae.

Boronia tenuis, Benth.

Bentham's description of this species requires alteration in one point, namely, the colour of the flowers. This he described as blue. Mr. A. Cayzer collected this species at Guppy's Siding in Spring, 1918, and found that in a field the flowers are pink.

Boronia tenuis is a Swan River species classified by Bentham under the Cyaneae, a series distinguished from the *Variabiles* by the blue or bluish petals instead of red or pink. This classification works well for dried specimens, but this particular example shows that it is useless in the determination of fresh material, as on drying the petals of B. *tenuis* become blue. The pink colour can be restored readily by treatment of the petals with hydrochloric acid, and the blue again produced by treatment with ammonia. The pink colour is also restored when the flowers are kept moist in an atmosphere of carbon dioxide. The conclusion is that the change of colour is due to the loss of carbon dioxide from the living petal on drying and the pigment remaining is blue. It is suggested that an action of the following type takes place :-



BLUE RED

Similar changes are produced in flowers of other Boronias and Eriostemons when treated with ammonia and with hydrochloric acid, but with these other species the mere loss of carbon dioxide does not seem to effect their colour, and such changes are only produced artificially by more violent reactions than the natural chemical changes.

FUNGI.

POLYPORACEAE.

Xylostroma gigantea, Fries.

Big Brook, February, 1919.

This fungus has been recorded in Victoria, New South Wales, and Queensland as attacking various Eucalypts. In February, 1919, I found it in the heartwood of fallen Karri logs (*Eucalyptus diversicolor*, at Big Brook. It occurs in thick interwoven sheets resembling chamois leather, and is probably the sterile state of one of the Polyporaceae. Fruiting bodies have not yet been observed.

PHALLOIDEAE.

Lysurus Gardneri, Berkeley, Lysurus australiensis, Cooke and Mass.

South Perth, April, 1919.
Claremont, April, 1920.

This terrestial fungus, previously unrecorded in Western Australia, was described by Cooke and Massee in Grevillea XVIII., 6 (1889), as *Lysurus australiensis* and is now referred to *L. Gardneri.* Berk. Its previously known Australian localities are Queensland and New South Wales. In appearance it somewhat resembles a star fish on a cellular white stalk several inches in height. The lobes are tawny in colour and slimy, but the most noticeable point is the fetid smell, which attracts flies, chiefly blowflies, from far and near. This smell is characteristic of the Phallaceae family and of the allied family Clathraceae, both of which are grouped together as the Phalloideae. Flies feed on the slime and, flying elsewhere, distribute the spores far and wide. In the case of Phallus, an allied genus, it has been shown that the spores germinate better after passage through the alimentary canal of the fly. Perhaps this is also true of Lysurus. On the 24th of April, 1919, several blowflies were confined in bottles with specimens of the fungus and ate the slime greedily. Two deposited eggs in it and these hatched.

One of the flies was removed and washed with distilled water and placed over a gelatine plate in a petri-dish to excrete, the object being to determine if germination of the spores was any more rapid after passage through the alimentary canal. A control culture of spores which had not been so treated was made. There was no germination in a fortnight, and by this time the first gelatine culture was badly infected by bacteria, evidently originally derived from the excreta of the blowfly. By this time the fungus was unobtainable, and further experiment could not be made.

The food value of the fetid slime is very low, and maggots and flies of various species, such as blowflies, house flies, and metallic blue flies (*Rutila decora*), though feeding greedily on it, died in about two days when confined on it. A specimen of the fungus left out on the laboratory table often had up to a dozen flies of various species on it. The smell is restricted to the slime. The vegetative part and the immature fruiting body, before slimy degeneration of the basidia takes place, possess the typical mushroom smell.

THE OCCURRENCE OF THREE SPECIES OF STENOCHITON IN WESTERN AUSTRALIA.

By Edwin Ashby, F.L.S.

Communicated by D. A. Herbert, M.Sc : 8th June, 1920.

Introduction.—In my monograph on the Genus *Stenochiton* Ad. and Ang. (Trans. R. Soc. of S.A., Vol. XLII., 1918), I suggested that the distinctive characters of this group warranted its elevation to full generic rank and gave an amended description of its generic characteristics.

All the species at present known are found living on Sea grasses (*Fluviales*). Up to the present I have failed in all attempts to keep them alive in aquariums for observation, so that, while one is fairly confident that they obtain their food from their host plants, this has not yet been satisfactorily demonstrated. Of the five species known all have been described from the State of South Australia and only two previously isolated records exist of their occurrence outside that State. One from Victoria, a single specimen, was wrongly identified by Sykes (Proc. Mal. Soc., Vol. II., pt. 2, July, 1896), as *S. juloides* Ad. and Ang. but was afterwards corrected to *S. pallens* Ashby, by Gatliff and Gabriel. The other is from Western Australia, three valves only, in shell sand at Albany, of *S. juloides* Ad. and Ang. (Torr. Trans. Roy, Soc. of S.A., XXXV., 1911, p. 96).

Now, as the result of the earnest work of Mr. W. B. Alexander, M.A., Keeper of Biology, Perth Museum, we are able to record the addition of two more species to the fauna of Western Australia, and the fact that *Stenochiton juloides* Ad. and Ang. has now been taken alive in the same State. (I most heartily congratulate Mr. Alexander and his co-workers on obtaining such gratifying results.)

In a letter from Mr. Alexander to myself, dated 12th December, 1919, he says "I am sending you a number of *Chitons*, obtained at the bases of the leaves of *Posidonia australis*, on the shore of Garden Island. I expect that they are specimens of *S. juloides*, A. & A. and S. *Posidonialis* Ashby, but I should be very glad if you would identify them. These were obtained on an excursion made by the Royal Society to the island on December 6." I wrote at once, stating that his identification was quite correct, and I trusted that he would be able to make further search in the situations I had described in my monograph on the *Stenochitons*, and I felt confident that a third species, if no more, would be discovered.

Again, on 13th January, 1920, Mr. Alexander writes, "That he had just returned from another visit to Garden Island and sent a parcel containing representatives of *Onithochiton scholvieni*, Thiele, *Liolophura gagmardi*, Blainville, *Plaxiphora albida*, Blainville, all more or less eroded, and one specimen of *Ischnochiton contractus*, Reeve, and a number of *Stenochiton posidonialis*, Ashby."

These were sent for my identification. While all the *Stenochitons* sent were of the one species, I gathered from his remarks that he had obtained one specimen of *S. cymodoceali*s, Ashby, but through some accident or oversight it was not included in the material that reached me.

Mr. Alexander then made an unsuccessful search for the latter species in the beds of Cymodocea at Cottesloe and, finally, on again visiting Garden Island his perseverance was rewarded by finding five specimens of undoubted *S. cymodoceali*s, Ashby, on the stems of *Cymodocea* growing in Careening Bay

Descriptions of specimens collected.

Stenochiton juloides, Ad. and Ang. (Proc. Zool. Soc., 1864, p. 193, op. cit. 1865, pl. fig. 15). Ten specimens of this species were sent, all collected at Garden Island, W.A., on the occasion of the Royal Society's excursion to that place on 6th December, 1919, and taken from the leaf blades of the Sea Grass *Posidonia australis*. The largest measures 11mm. in length or about one-quarter the size of a fully developed adult. The shells highly polished and practically unsculptured, of a chocolate colour, in some flecked and streaked with grey. In fact they are similar in all respects to the juvenile shells of this species occurring in South Australia. Unfortunately the specimens in question are covered with a thin film of salt or some preservative fluid, so that unless wetted or varnished, the true colour is not quite clear.

No adult specimens were obtained, probably because only the blades of the ribbon-like leaves were examined. It is necessary to dig or grub up the roots of the *Posidonia* to obtain adult specimens, the *Chitons* living between the brown sheaths of the shoots usually buried in the sand about three inches. This species prefers sheltered beds of *Posidonia* rather than those in more exposed situations.

Stenochiton posidonialis, Ashby (Trans. Roy. Soc. of S.A., Vol. XLII., 1918). A new record for Western Australia.

All the shells were of the usual characteristic shape, long, flat, rounded, smooth, and highly polished. The anterior valve concave and the posterior flat and long, all of a more or less transparent green shade flecked with darker markings, the dorsal line being outlined for the full length, on some specimens, by a wavy pale pink line or band ; the largest about 8mm. in length, whereas I have collected them up to 20mm. in length in South Australia.

but they are more often about the same size as those now under review.

There was a large number of quite juvenile specimens, which suggested from their greater proportional width, that they might be referable to the sub-genus *Zostericola*, Ashby, but they all show the concave anterior valve which is characteristic of the foregoing species.

Variety (1)—Nine of the specimens, or 11 per cent., are transversely banded or blotched with brown on a white ground; but the shape of the shell is normal, showing that it is only a colour variation. This particular variety was noted in my monograph; the percentage of this variation to the normal shells is much greater than I have found to be the case in South Australia.

Variety (2)—Four specimens have a dorsal line marked out in brown; this form also occurs in South Australia and was noted in the paper aforesaid.

Variety (3)—In this specimen there is no distinct colour divergence, but the slope of the anterior valve is almost straight.

Stenochiton cymodoceälis, Ashby, (loc. cit.). A new record for Western Australia.

Five specimens were sent me by Mr. Alexander under cover of letter of 4th March, 1920. The largest is a shade over 8mm. in length, the normal colour is olivaceous green to brighter green, dashed with darker green shades, and most show a more or less defined pink dorsal band. They are quite typical, smooth, polished, highly arched, tapering at both ends and the girdle incurved, due to its habit of clinging to the cylindrical stems of the Sea Grass *Cymodocea antarctica*. Mr. Alexander found them in the beds of that plant at Careening Bay, Garden Island. Although he devoted a whole morning to the search he only obtained the five specimens. I think that beds of *Cymodocea* in sheltered positions will later on be found to yield them in greater numbers. Mr. Alexander made careful search for these shells in the beds of *Cymodocea* at Cottesloe without success, but Mr. Shelton, who was with him at the time of the Garden Island excursion, informed him that his school children found some specimens of this *Stenochiton* on one small patch of the same Sea Grass at Cottesloe.

In conclusion, it is with much gratification that I am able, owing to the kindness of Mr. Alexander, to record the foregoing discovery, Western Australia being the first State since the publication of my monograph in 1918 to extend our knowledge of these very interesting chitons. In the said paper I expressed the opinion that investigation by future workers, now we know where and how to search, will reveal many new forms of this genus, not only in the other States of Australia, but also throughout the world, wherever plants belonging to the order Fluviales (Sea Grasses) are found. W.A. has been the first to demonstrate the truth of this prognostication.

C. H. Ostenfeld (Dansk. Botanisk Arkiv. Nr. 6, 1916), states that there are 13 species of Sea Grasses recorded as occurring in Australian waters, seven of which are found in Western Australia. Up to the present I fear we have only searched for *Stenochitons* on two of these, *Posidonia australis* and *Cymodocea antarctica*, and these have been found to be the hosts of four species of *Stenochiton*; the fifth, *S. pallens*, Ashby, has up to the present only been met with by dredging and its host is not known.

May we not conclude that a diligent search on some of the other species of Sea Grasses will reveal new forms? I would, therefore, encourage all workers to an earnest search in all localities where these plants grow.

WATER LOCATING.

Two Reports of the Committee of the Royal Society of W.A., Appointed to carry out Tests of Water Locating by the Rev. W. Kennedy.

First Report -

Mr. Kennedy claimed to be able to detect moving water and to distinguish between fresh water and water containing too much common salt to be utilised by stock.

First Series of Tests.

In each of the following tests one gallon of water was used in an open glass container. The water was stirred with a rod and Mr. Kennedy carried out his tests immediately over the jar. The filter referred to as used by him consisted of a pair of small bags of cloth filled with common salt and placed between his thumbs and the divining rod.

Test No.	Contents.	Reaction of the Rod.		Conclusion drawn by Mr. Kennedy.
		Without Filter.	With Filter.	
A.	5% $MgSO_4$	Positive	Positive, weak	No common salt, or slightly salt.
B.	5% NaCl	Positive	None	Salt.
C.	0·5% NaCl (Suitable for Stock.)	Positive	Positive	Fresh.
D.	5% NH Cl	Positive	Positive, very weak	Brackish or stock water.
E.	Fresh Water (Perth Tap Water)	Positive	Positive	Fresh.
F.	5% Na_2CO_3	Positive	None	Salt.

B., C., and E., were direct tests on Mr. Kennedy's claims, and his conclusions, as given above, were correct. A., D., and F. were introduced to ascertain if related salts had any effect on the rod.

Second Series of Tests.

Five one inch hose pipes were laid in parallel lines on the surface of the Museum Quadrangle, both intake and outlet ends being concealed. Arrangements were made so that, unknown to the person under test, water could be passed through any one hose or any two hoses at a time. The ground had previously been examined by an amateur douser who reported the ground as free from effect of underground water.

Several heavy showers of rain fell between this amateur's test and Mr. Kennedy's tests.

Mr. Kennedy began the test with a blank trial, all the hoses being empty. On the first traverse he obtained no reaction over hoses 1, 2, and 3, but positive reaction over hoses 4 and 5, beneath which he declared there was underground running water which would vitiate any tests with hoses 4 and 5. On a second traverse immediately following the first, Mr. Kennedy obtained a positive reaction over all five hoses, and declared the whole area affected by underground water. This series of tests had, therefore, to be abandoned.

The tests, which were, at best, merely preliminary, had therefore in the end to be greatly curtailed. It is thus impossible to draw general conclusions from the experiments, but the Committee are of the opinion that the results justify fuller inquiry and they recommend that further investigations be made.

EDWARD S. SIMPSON.
W. J. DAKIN.
A. D. ROSS.

Perth, 18th August, 1919.

SECOND REPORT-

The following is a report of some further tests carried out by the Rev. W. Kennedy, at the University, Perth, on the afternoon of 16th April, 1920, in the presence of Professor Ross and Dr. Webster (members of the Committee).

THIRD SERIES OF TESTS -

To decide definitely the meaning of the terms "brackish," "salt," etc., as used by Mr. Kennedy, he was asked to test the effect on his rod (with and without filters) of one gallon of pure fresh water, rapidly stirred in a glass container, to which a strong salt solution (125 grams to the litre) was gradually added. The results are set out in Table I.

TABLE I.

Actual Salt Content.	Mr. Kennedy's Report.
Up to 0·10 per cent. ...	Water apparently quite fresh.
At about 0·12 per cent. ...	Effect of salt barely detectable.
At 0·2 per cent.	Effect still very slight.
At 0·28 per cent.	Water beginning to be brackish.
At 0·37 per cent.	Water slightly brackish.
0·42 per cent. to 0·58 per cent.	Water brackish.
At 0·7 per cent.	Brackish to salt- -doubtful water.
Over 0·84 per cent.	Thoroughly salt.

The following divisions or classes were evidently fairly well marked, viz.:

TABLE II.

Class No.	Distinguishing Name.	Salt Content. Percentage.	Grains per Gallon.
i.	Fresh water	0·0	0
ii.	Good, but not quite fresh	0·15	105
iii.	Fresh to brackish	0·3	210
iv.	Brackish	0·5	350
v.	Very brackish or doubtful water	0·7	490
vi.	Thoroughly salt	Over 0·8	560

Fourth Series of Tests.

Five jars, 1, 2, 3, 4, 5, were used, each containing one gallon of pure fresh water. To 2, 3, 4, 5, sodium chloride had been added to give a salt content of 0·5, 1·0, 3·0, and 5·0 per cent. respectively. All the solutions had been carefully filtered. The jars were brought into the room for test, one at a time, in the following order, Nos. 4, 3, 1, 2, 5, 5, 1, 2, 3, 4, 2, 1, 5, 4, 3, care being taken that Mr. Kennedy should be unaware of the return of any jar for retesting.

The inferences drawn by Mr. Kennedy are shown in the following table:—

TABLE III.

Jar.	Salt Content percentage.	No. of Test.	Rev. Mr. Kennedy's Inferences.
1	0·0	3	Brackish—good Stock Water.
		7	Good drinking Water, but not quite fresh.
		12	Fresh Water.
2	0·5	4	Brackish—good Stock Water.
		8	Too Salt for use.
		11	Very Brackish.
3	1·0	2	Doubtful Water—almost Salt.
		9	Between Brackish and Salt.
		15	Salt.
4	3·0	1	Salt—unfit for use.
		10	Practically fresh Water.
		14	Very Brackish
5	5·0	5	Fresh Water,
		6	Salt.
		13	Salt.

In Table IV. these results are summarised by referring to the actual and inferred salt contents according to the classes (I) to (vi.) into which Mr. Kennedy professed to be able to differentiate waters (*see* Table II.). In the last column of the table the term "percentage inaccuracy" has been used as a heading. Fifty per cent. inaccuracy would be the probable inaccuracy on a large number of tests carried out on a person giving his inferences by random guesswork. The results in Table IV., while not nearly so accurate as the few obtained at the Society's meeting last August, nevertheless show a steady margin of successes above those to be expected if the inferences had been mere guesswork.

TABLE IV.

Jar.	Classification.		Classification Errors.		Probable Total on Pure Chance.	Percentage Inaccuracy.
	Actual.	Mr. Kennedy's.	Individual.	Total.		
1	i.	iv. ii. i.	3 1 0	4	7·5	21
2	iv.	iv. vi. v.	0 2 1	3	4·5	33
3	vi.	v. v. vi	1 1 0	2	7·5	13
4	vi.	vi. ii. v.	0 4 1	5	7·5	33
5	vi.	i. vi. vi.	5 0 0	5	7·5	33
			Average percentage inaccuracy about			25

Fifth Series of Tests.

On a portion of ground, previously proved by Mr. Kennedy to be free from any vitiating effects of underground water, etc., two three-quarter inch hose pipes were laid several yards apart. Arrangements were made whereby fresh water could be run down hill through the pipes in a rapid current. Mr. Kennedy was asked to make nine successive tests, stating in each case whether or not each pipe was carrying water.

The results obtained are set forth in Table V.:

TABLE V.

Test.	Water passing in.	Rev. Mr. Kennedy's Inference. Water passing in –
1	Pipe I.	Pipe II.
2	Pipe II.	Pipe I.
3	Pipe I.	Both pipes, but not much water.
4	Neither pipe ...	Neither pipe.
5	Pipe II.	Pipe I.
6	Pipe I.	Pipe I.
7	Neither pipe ...	Pipe II.
8	Pipe II.	Both Pipes, but little in Pipe II.
9	Pipe II.	Pipe I.

In all cases when water was passing the current was rapid, as much as the hose could carry. The results are therefore decisively against the divining rod being of use as an indicator of the flow of water in such pipes.

The Committee feel that the great excess of failures over successes shown in Table V. is not to be described to any "reversed" action of the rod, but is merely an example of the discrepancy from average probability estimates to be expected when dealing with a limited number of tests. This fact must be carefully borne in mind in connection with Table IV., which showed a three to one ratio of successes to failures.

In conclusion the Committee have to report that Mr. Kennedy in a recent letter states that he can get no positive effects with water in pipes. As the results of the other tests described in this report would not justify the expense of field tests necessitating the sinking of wells, the Committee desires to be relieved from further investigations.

A. D. ROSS,
ALFRED WEBSTER,
WM. E. SHELTON.

Perth, 30th April, 1920.

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